MEMOIRS

OF THE

WERNERIAN

NATURAL HISTORY SOCIETY.

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NATURAL HISTORY SOCIETY.

Vol. II.

FOR THE YEARS 1811,—1816.

WITH TWENTY-SEVEN ENGRAVINGS.

EDINBURGH:

PRINTED FOR ARCHIBALD CONSTABLE & CO.

AND FOR

LONGMAN, HURST, REES, ORME & BROWN,

LONDON.

1818.

NEILL & Co.
Printers.

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ERRATA IN VOL. II.

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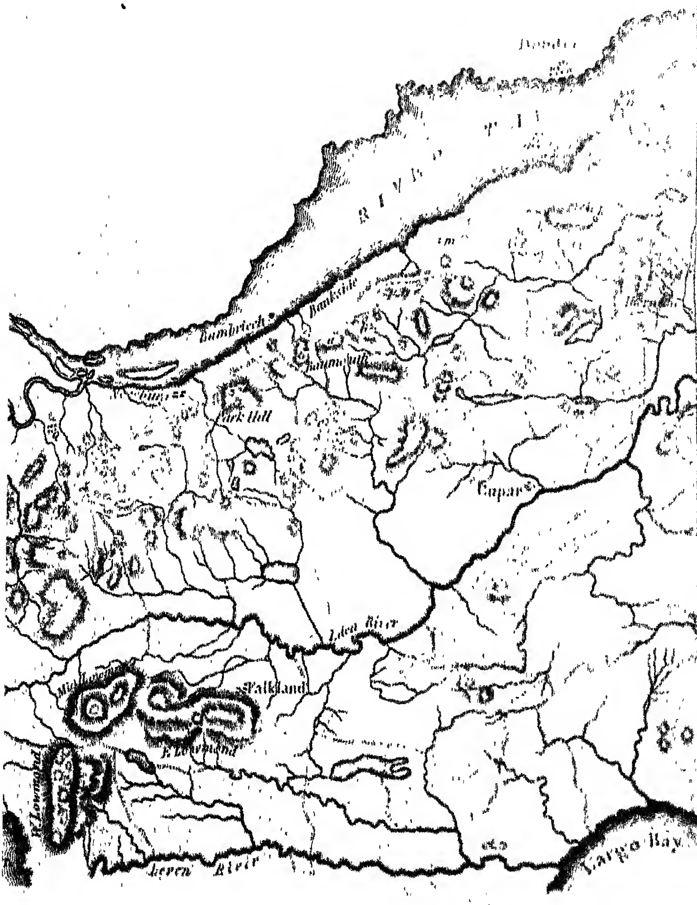
38.	ib. *pro* atro *lege* atrâ
58.	16. *pro* pupillo palvinato *lege* pupillâ pulverulento
63.	18. *pro* nigricans *lege* nigricantes
ib.	22. *pro* cincrascenti *lege* cincrerascente
77.	*ult.* *pro* SPONGIA *lege* SPONGIÆ
78.	2. *pro* SPONGIA BRITANNICA *lege* SPONGIÆ BRITANNICÆ
612.	Note, last line but one, *for* pelarins, *read* pelerins,
624.	13. *for* occasionally marly, quartz, or calcareous matter, *read* marl, quartz, or calcareous matter,


MAP
of the
OCHIL HILLS
Devon R
Alloa
South Devon R
Forth R
Stirling
Loch
Leven
Dunning


Bankside
Park Hill
Cupar
Eden River
Falkland
E. Lomond
W. Lomond
Leven River
Largo Bay

MEMOIRS, &c.

I. *Outlines of the Mineralogy of the Ochil Hills.*

By Charles Mackenzie, Esq. F.L.S. F.W.S., & Member of the Geological Society.

(*Read 14th November* 1812.)

If the true ends of science be promoted rather by careful observation than by vague hypothesis, the Geognosy of Werner has peculiar claims to admiration. Without the lofty pretensions which constitute the chief distinction of some speculations, it has established general principles, which facilitate the labours of the student, and prompt to continued exertion. A system which developes the great laws of nature, and is substantially improved by the examination of her works, is of all others the best calculated to promote every science; and accordingly we find, that mineralogy has made the most rapid advances wherever this has been fairly adopted. Formerly, mineralogical inquiries produced nothing more than a mere catalogue of localities; but now many relations of individuals have been distinctly deter-

mined; others are daily ascertained, and the most doubtful will probably be accurately known at a period not very remote. The correctness of these observations, is shewn by the history of mineralogy within a very few years, during which there has been an immense accumulation of geognostic facts collected from portions of the whole known world. In Britain alone, has the comparative progress of the science been unequal to the apparent ardour with which it has been pursued, and unworthy of the example afforded by our indefatigable and justly distinguished President. With a view of contributing as far as it is in my power to remedy this deficiency, I have examined the interesting district of the Ochil Hills; and I now beg leave to lay the general results of that examination before the Society. In many instances they will be found imperfect and unsatisfactory. It would have been gratifying, had it been possible for me to have made them more complete; but as circumstances render that wish unavailing, I trust that others, whose opportunities may be more favourable, will be prompted to retrace my steps, to correct my errors, and to add new facts to those I shall detail.

General Description.

Modern geographers consider the Ochil Hills as the southern boundary of the Grampians; and in that point of view, the eastern portion may be

traced to the Seedlay Hills; while the western extremity should be regarded as a *mountain-arm* stretching into the extensive valley which reaches from the verge of the Grampians, properly so called, to the shores of the Forth: but as the present object is to give a sketch of their particular structure, without entering more into their general relations than distinctness requires, it will be convenient to view them as a *small mountain-group*, which rises above the sea-port of Parton Craigs, on the right bank of the Tay, and, after having skirted the northern parts of Fifeshire, traversed Perthshire, bounded Kinross-shire and Clackmananshire, through a course of more than fifty miles, terminates on the river Allan, near Dunblane, in Stirlingshire.

This group consists of a high chain, the loftiest point of which, at its first rise *, does not exceed three or four hundred feet; but more lofty † summits occur to the westward, until Bencleugh ‡ and Dalmyatt, rear their heads at an elevation of more

* Craig Law, above the village of Parton Craigs.

† The following are the most remarkable, going from east to west. Norman's Law, Glenduchy hills, Clachert Craig, the hills of Abernethy, Castle Law, Sea Male, King's Seat, Bencleugh, Dalmyatt; besides many others which may be traced in the map.

‡ Above the village of Westertown, &c.

than 2000 feet above the level of the sea. Several smaller chains may be traced in a course nearly parallel to that of the most elevated, particularly to the south, where they may be distinctly seen gradually diminishing, until they are lost in the adjacent valleys. In a few instances, as at the south-eastern extremity, they diverge from the general direction, forming small mountain-arms, which bound some lateral valleys of great fertility and beauty.

The individuals of which this group is composed, are generally long round-backed hills, very richly covered with verdure, having occasionally conical and rarely tabular summits. Those of the first description, are most numerous between Parton Craigs and Abernethy, and those of the latter, between Dunning and the Yetts of Muckhart; and it is worthy of remark, that the former are more completely covered up than any of the other hills.

The *acclivities* look to the north, and are generally rapid, though there are some remarkable exceptions to this observation. The *declivities* are very gentle, except at Bencleugh, where they are in many places nearly precipitous. A very large proportion of the Ochil Hills are cultivated to the very summits, and nearly the whole of the remainder are excellent pasture. The natural consequence of this is, that there are few openings, except in an accidental quarry, or some rare natu-

ral exposure *, circumstances which embarrass the mineralogist in no common degree.

The *dip* of the strata, with very few exceptions, is to the south-east, corresponding with the declivities; and the *direction* from north-east to south-west, corresponding with the direction of the whole group, which runs about half of its course from east to west, and then, changing its direction, runs from north-east to south-west.

Springs are very numerous throughout the whole of the Ochil Hills; in some instances they form pools, in others bogs, and in many they unite and give rise to several beautiful small streams, that meander through the neighbouring districts. The Devon, the Allan, and the May, are the most remarkable of these streamlets; and they pour their waters into the Forth, the Tay, and the Erne.

The *valleys* are also numerous, separating the several chains, and the individual heights from each other. In general they are narrow, not exceeding thirty or forty yards in width; their length depends on that of the chain, or mountain which they bound. These valleys are most numerous at the western extremity of the Ochils,

* Such is exhibited in the magnificent range of columns, which may be traced nearly from Craig-in-Crune to Clachert Crag.

where they are also most extensive. They imperceptibly diminish both in size and importance to the eastward. It is, however, in the latter portion that the romantic valley occurs, in which the Lake of Lindores is contained. In this small spot, nature has crowded together all that can delight the eye, and elevate the imagination.

The Ochil Hills are bounded to the north and north-west by the Frith of Tay, Strath-Erne, and Strath-Allan; to the south-west by the vale of Forth; to the south by the vales of Devon, of Kinross, and of Eden; and to the east by the left bank of the Eden, where it is lost in the right bank of the Tay.

The prevailing rock throughout the whole of the northern boundaries, is a dark brick-red Sandstone, which extends as far as Callendar to the west, and to Stonehaven * to the east, and is in all probability the *old red sandstone*. The independent coal formation, according to Mr Bald †, forms the coal-field of Clackmananshire and Stirlingshire; and the red sandstone, occasionally assuming the characters of conglomerate ‡, again occupies

* See Colonel Imrie on the Conglomerate, &c. vol. 1. Wernerian Memoirs.

† See Mr Bald on the coal-field of Clackmananshire, vol. 1. Wernerian Memoirs.

‡ This is distinctly the case immediately to the north of Cupar, in a small opening made by the rivulet which empties itself into the Eden below the town.

nearly the whole of the valleys of Kinross and Eden; while grey sandstone, slate-clay, bituminous shale, pitch-coal, and clay-ironstone, form the right bank of the Eden, to the south of St Andrew's. On the left bank, which is more immediately contiguous to the Ochils, beds of sand, clay and marl have been observed.

The rocks composing the Ochil Hills, occur in nearly the following order:

1. Red sandstone.
2. Amygdaloid.
3. Grey sandstone.
4. Limestone.
5. Slate-clay.
6. Claystone.
7. Tuff.
8. Basaltic clinkstone.
9. Greenstone.
10. Claystone porphyry.
11. Felspar porphyry.
12. Compact felspar.

I. *Red Sandstone.*

This rock occurs for the first time, in travelling from east to west, on the shore below Birkhill. It is also found in a quarry between Bambriech Castle, and Newburgh; in the small hills between

Pitcaithly * and Dunning; and to the westward of the latter place. Its colour is a dark brick-red, brownish red, and reddish grey. It is coarse-grained, occasionally it becomes conglomerated, as to the south of Dunning, where it rests on the reddish-grey sandstone, and contains considerable masses of quartz, fine-grained sandstone, and scales of silver-white mica. This sandstone is occasionally highly crystalline, bearing some resemblance to iron-flint. When the mica predominates, it assumes a slaty character, and decomposes into tables.

It occurs distinctly stratified, dipping to the south-east, with an apparent direction from north-east to south-west. I have not seen it in connexion with any other rock, except below the Rumbling Bridge in the course of the Devon, where it alternates with a tuff; and at the foot of the King's Seat, near to the house of Harvieston †, where it rests immediately above a seam of slaty pitch-coal, six feet two inches thick. From the resemblance of its characters to those of another sandstone to be hereafter noticed, it is highly probable, that they will be found to belong to the same formation; but as they have not been traced in distinct connexion, it may be well to keep them

* This is a small village in Perthshire, celebrated for a mineral spring, to which considerable efficacy has been ascribed.

† The seat of my friend Craufurd Tait, Esq.

separate at present. At the base of Alva hill, it seems to lie below greenstone.

In a small valley which traverses the Ochils, between Wormit Bay, and a lateral valley that divides Newton hill from Sanford hill, there are several small hillocks of an ironshot sand, which contains masses of this sandstone. It is probable, that they have been derived from the decomposition of the red sandstone just described.

Although it has not been accurately determined, it is highly probable, that this red sandstone, from the number of points at which it occurs, and the coincidence between its characters and those of the *old* red sandstone which occupies the adjacent valleys, that they will be hereafter found to be intimately connected. At present, I shall hesitate to fix the place of this rock in the system, and content myself with observing, that it seems to be the lowest of the series composing the Ochil Hills.

II. *Amygdaloid.*

On the shore between Parton Craigs and Balmerino, (a district of nearly nine miles), a coarse Amygdaloid gradually passes into a finer variety of the same rock. The former of these consists chiefly of portions of the latter, binding together various substances. I could not discover the thickness of any of the beds; but I apprehend, from

having seen a different rock at a small height above it, that it is inconsiderable. The basis of this rock is a greyish-green claystone, occasionally very much ironshot. The numerous cavities contained in it, are lined with white amethyst, flesh-red calcareous spar, white felspar, chalcedony, red flint, and common quartz. The chalcedony appears to have been first deposited, and the quartz to have been the last.

The amygdaloid sometimes becomes porphyrytic, containing crystals of felspar.

It is difficult to assign to this rock its correct geognostic position. At Parton Craigs, it is below claystone porphyry. Near Newport, it alternates with basaltic clinkstone. At the western extremity of Wormit Bay, it is below the claystone, through which it seems to be connected with the tuff on the one hand, and with the claystone porphyry on the other. On the water of Fargs, which runs from Damhead * to Abernethy, it occurs resting on a variety of greenstone, which is connected with the clinkstone. In this last situation, it possesses a great variety of characters, being extremely coarse at one point, where a bed of clay-porphyry rests upon it. More to the southward, the vesicles in the amygdaloid become

* This place is about half way between Kinross and Abernethy.

very distinct, and contain a flesh-red variety of felspar.

This rock is traversed by veins of calcareous spar, which exhibit a sea-green colour, when fresh broken.

III. *Grey Sandstone.*

Above the amygdaloid *, beds of a yellowish grey sandstone alternate with tuff and claystone, which appear to be intimately connected with some varieties of the amygdaloidal rock. It contains a considerable quantity of scales of silver-white mica, and decomposes into slaty masses. It seems to pass almost imperceptibly into the varieties of claystone to be hereafter described. One variety of this rock has a very remarkable granitic appearance, and does in fact contain all the constituents essential to true granite. At the same time, however, it retains the distinctive characters of sandstone.

The relations of this rock to the older rocks, is not clearly made out, except at Wormit Bay, where it seems to rest on amygdaloid. It occurs frequently between Wormit Bay, and the village of Dunning in Perthshire. It also occurs in the course of the Devon, where it may be seen alternating with the red sandstone, to which in all probability it belongs.

* At the western extremity of Wormit Bay.

Its general dip is to the south-east, and its direction from north-east to south-west.

IV. *Limestone.*

In a quarry at the base of Park Hill, not far from Bambriech Castle *, a saddle-shaped mass of yellowish grey Limestone rests between beds of slate-clay and grey sandstone ; and above the newest sandstone, there is a bed of greenstone, the upper part of which is much decomposed. This limestone varies from an earthy to a highly crystalline structure, resembling if not passing into calcareous spar.

This is the only instance throughout the whole of the Ochils that I have seen limestone, although I have been assured, that other portions of it have been observed at a considerable elevation above the village of Abernethy. On examining the situations to which I was referred, I could discover no traces of limestone ; from which I have been induced to suspect, that the popular belief is unfounded.

* Bambriech Castle stands on a promontory of red sandstone, which runs a short way into the Tay, from its southern bank, about three miles to the eastward of the small sea-port of Newburgh. Immediately to the south of the castle, the Ochils rise very rapidly, and receive different names. That of Park Hill, is appropriated to the hill half way between Newburgh and Bambriech.

V. *Slate-Clay.*

Thin seams of a bluish-grey Slate-clay, possessing the common characters, occur both above and below the limestone, separating it from the grey sandstone.

VI. *Claystone.*

This is a very abundant rock, and some very beautiful varieties of it occur in the course of the Ochil Hills. At Lucklaw *, it appears to pass into basaltic clinkstone; below Birkhill †, it alternates with sandstone, tuff and felspar, passing on the one hand into the grey sandstone, and on the other, through all the varieties of tuff and clinkstone, to the perfectly compact felspar. It is also found between the Yetts of Muckhart and Alva, below the clinkstone, with which it probably alternates.

It is fine-grained, having a large flat conchoidal fracture, and an uneven cross fracture. It occasionally contains scales of silver-white mica, particularly where it alternates with the sandstone and tuff, as it does below Birkhill. The colour is various, even in the alternating strata; the most common, however, is between pearl grey and isa-

* This is a small hill between Cupar and Parton Craigs.

† An eminence about five miles to the westward of Woodhaven.

bella yellow. It sometimes, though rarely, is amygdaloidal: the cavities of such varieties, are filled with green earth, and white calcareous spar: crystallised felspar is dispersed throughout the mass.

The claystone alternates with the grey sandstone and the tuff, between which it is most probably the connecting link; for it passes almost imperceptibly at its extremities into each of them. It is doubtful, whether or not the claystone be of older formation than the limestone, as I have seen both in similar relations to the sandstone. The present location, therefore, of these rocks, in so far as they regard each other, must, until more extended observations shall have been made, be considered as entirely arbitrary.

VII. *Tuff.*

A very remarkable tufacious rock occurs above the claystone at the base of Birkhill, and at the western extremity of Wormit Bay. In both of these situations, it alternates with the sandstone and claystone. In no other part of the Ochils have I observed a similar arrangement.

This tuff is coarse, inclosing portions of felspar, which is sometimes lost in the prevailing mass. The chief colours are, flesh-red and Isabella yellow. It appears to be one of the newest members of the sandstone series, and there is a gradual passage from it to the claystone. It is distinctly

stratified, having the general dip, direction, and inclination of the whole mountain-group.

VIII. *Basaltic Clinkstone.*

From the first rise to the final termination of the Ochil Hills, Clinkstone is the prevailing rock. It occurs at Parton Craigs, resting on, and in one instance alternating with, the amygdaloid; from Craig-in-Crune, (half way between Woodhaven and Newburgh,) it forms the summits of the hills, occasionally exhibiting columns of more than 100 feet in height, which rise precipitously from the low lands on the south bank of the Tay, and produce a noble and imposing effect *. At the more western portions of this district, the clinkstone is connected with greenstone, felspar porphyry, and compact felspar. At Westertoun, immediately above the junction with the coal-field of Clackmananshire, it occurs distinctly stratified, the beds being separated from each other by thin seams of leek-green steatite, which contains iron pyrites in considerable abundance. It occasionally assumes the characters of basalt: at other times, it is more decidedly clinkstone; but it most gene-

* This is remarkably the case in the hills between Craig-in-Crune, and Norman's Law. The columns there have a diameter of from five to seven feet. They are pentagonal, as it usually happens.

rally possesses characters intermediate between those of basalt and clinkstone; from which circumstance, I have been induced to adopt the name of Basaltic Clinkstone, which applies equally to every variety.

Its colours are blackish-grey, blackish-brown, and sometimes it is much ironshot, particularly at the summits of the lower hills. Its fracture is slaty and rough, and in general it emits the clinking sound to which the species owes its name. Beautiful specimens of an amygdaloidal variety occur between Abernethy * and Kinross.

The dip and direction of the stratified portions of this clinkstone, correspond with the general dip and direction.

IX. *Greenstone.*

Throughout the district which extends from Parton Craigs to Newburgh, the clinkstone frequently passes into greenstone; and in the immediate vicinity of the latter place, it appears distinctly columnar, though its relations to every other rock are wholly undefined.

It is not improbable, from similar greenstone being found in higher portions of the hills between Newburgh and Woodhaven, that it alternates with

* The hills in this district are very picturesque, and have (I believe) appropriate names, though I could not learn them, as every shepherd furnished one of his own.

the clinkstone. Between Dunning * and the Yetts of Muckhart, it occurs frequently above the clinkstone, and below felspar-porphyry; but is seen in greatest abundance, variety, beauty, and distinctness between the Yetts of Muckhart and the western extremity of the Ochils, particularly in an exposure made by a streamlet which divides the King's Seat from Craiginnan †, and in a section above the village of Westertoun. In this district, it forms separate hills, or their caps, and in the central parts of the group, it alternates distinctly stratified with the basaltic clinkstone, which it connects with the felspar rock through the felspar porphyry. The section above Westertoun, may be considered a beautiful epitome of these alternations, and it receives an additional interest from its exhibiting a fine view of the junctions of the Coal-field, with the newer rocks. The beds of greenstone have a dip and direction at right angles, to the dip and direction of the clinkstone, from which it is separated by thin seams of

* The observation made on the hills between Abernethy and Kinross, applies to those of the above portion of the Ochil Hills. The confusion arising from a perpetual repetition of names, has induced me, in many instances, to omit them altogether.

† Craiginnan is the hill which rises immediatly behind Dollar, and is connected by a series of conical hills with the romantic and precipitous Craig Rossie, which rises to the westward of the village of Dunning in Perthshire.

decomposing steatite. The beds of the greenstone itself are also separated by thin seams of this steatite, which contains considerable quantity of iron pyrites. The gradation * from the rock in which the hornblende predominates to that in which a beautiful flesh-red felspar prevails, is marked in a series of six alternating portions of greenstone and clinkstone, which commence at the above-named section, and may be traced in the face of Bencleugh beyond Alva.

It is worth recording, that a bed of greenstone occurs in a coarse conglomerated rock in the hill of Balcanquhal †. It is of small extent, and may be seen in all sides except at its base. There can therefore be no doubt of its relations to the rock in which it is imbedded, from the characters of which it may be fairly presumed, that it does not owe its existence to volcanic agency ‡.

The characters of the greenstone, are those which commonly occur, except in the higher alternating beds, where they assume those of the

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* It is a curious fact, that all the red varieties of rock that I have observed in the Ochils, occur at the highest points. It is difficult to form even a conjecture as to the cause of this.

† About three miles from Kinross, to the north of the road between that place and Cupar.

‡ If this bed of greenstone were spouted up from the centre of the earth, the intensely hot fluid mass must have acted on the bed through which it flowed. But of this action there is no evidence.

rock, which Mr Jameson calls Sienitic Greenstone. It is occasionally porphyritic, containing fine and indistinct crystals of rutilite.

X. *Claystone-Porphyry.*

On the south side of the Abernethy hills, a bed of flesh-red claystone porphyry, with crystals of glassy felspar, is above the clinkstone, and some varieties of greenstone, but its relations are wholly undefined.

XI. *Felspar-Porphyry*

Forms the caps of the highest hills which lie between Dunning and Dunblane. It is a compact flesh-red felspar, containing crystals of white calcareous * spar. In the course of the streamlet which runs past Castle Campbell, it alternates with greenstone. It occurs in decomposed fragments on the summits of Craiginnan, King's Seat, Bencleugh, and Dalmyatt. These decomposed fragments have a vesicular appearance, from a very obvious cause, (the rapid decomposition of the included crystals). This appearance would no doubt be ascribed to

* This appears to be intimately connected with the sienitic greenstone. Some beautiful masses of this rock are to be seen higher than the greenstone, at Craig Rossie, near to Dunning.

volcanic agency, by those whose zeal for hypothesis outstrips their love of accuracy.

Only the lower portions of this rock contain crystals of hornblende, which give way at the higher points to those of calcareous spar.

XII. *Compact Felspar.*

Very beautiful brick-red and flesh-red compact felspar, possessing all the usual characters, forms the caps of some of the smaller hills of the southern chain of the Ochils, which extends from the neighbourhood of Dollar, to the banks of the Eden. Near Cupar, it occurs so abundantly, as to be the sole material for repairing the roads. It appears to be the newest member of the series, and to correspond both in its individual characters, and in its geognostic relations with the felspar of the Pentland Hills, where it was first noticed forming distinct masses by Professor Jameson. At the summit of Lucklaw, this felspar passes into hornstone. A solitary bed of it is to be found in the alternating series of sandstone, claystone, and tuff, in Wormit Bay.

VEINS.

Having thus briefly noticed the prevailing rocks, I shall now mention the veins traversing these

rocks, in the order of the strata in which they occur. Contemporaneous veins are not uncommon in the clinkstone and greenstone; but true veins are more rare. The following is the order of the latter:

1. Calcareous spar. 2. Steatite.
3. Heavy-spar.
4. Iron. 5. Cobalt. 6. Silver.
7. Copper. 8. Lead.

Calcareous Spar.

Highly crystallised varieties of the calcareous spar traverse the clinkstone, near Woodhaven, and the claystone near to the Rumbling Bridge. It has a greenish tint, and all the usual characters. The dip and direction not easily determined. The thickness from half an inch to two inches.

Steatite.

Veins of this steatite, varying from one to two inches, divide the strata of the clinkstone, and of the greenstone, at the section above Westertoun and Alva. They occasionally contain iron-pyrites crystallised, in cubes, in considerable quantities.

Heavy-Spar.

Straight lamellar heavy-spar is the veinstone of the mine behind Castle Campbell, of those of Alva Hill, and Airthry Hill, in all of which it traverses the newer varieties of the clinkstone, which approach to felspar through the greenstone. They are four or six feet wide, with their outgoings to the south. Dip near 45° to the north-east; but from the falling in of the roofs and other accidents, it was impossible for me to ascertain any particulars respecting them. It is in these veins of heavy-spar, that the cobalt, silver, copper, and lead, have been deposited. Of the two first of these, I could discover no trace; though there is no doubt that both have been obtained in considerable quantity. The fullest account I have been able to meet with of the silver mines, is that contained in Sir John Sinclair's Statistical Account of Scotland, under the head Alva. Of the cobalt, I have seen no published account. It appears, that both these metals were found in the Alva Hill.

Copper and lead are still to be found both in the mine behind Castle Campbell, and in the mines of Alva. But the specimens (which alone I could procure) at the entrance, are so much acted upon by the weather, that I cannot venture to at-

tempt any description of the varieties of ore that occur. The first named of these mines has been twice opened since the year 1760, but has been abandoned on both occasions. But it is not determined, whether or not the want of success has arisen from mismanagement, or from the unproductiveness of the mine. From their present state, I found it impossible to make any accurate observations on them.

Such are the most important facts that I have noticed in the examination I have been able to give to the Ochils. Although the information I have collected be imperfect, I trust that the Society will receive it as a pledge of my readiness to contribute all that I can to the science of mineralogy. It may be expected, that I should assign the geognostic place of the Ochils. With the limited observations that I have made, I could do no more than throw out conjectures, which would not conduce to the legitimate ends of science. Until more extended examinations shall have been made, I must beg leave to confine myself to a simple narrative of facts.

II. *A Geological Account of the Southern District of Stirlingshire, commonly called the Campsie Hills, with a few remarks relative to the two prevailing Theories as to Geology, and some examples given illustrative of these remarks.*

By Lieutenant-Colonel IMRIE, F. R. S. Edin.

(Read 1st February 1812.)

THE tract of country to be here described, is at present denominated the Campsie Hills, and was formerly called Lennox. It is almost entirely situated in Stirlingshire, and forms the southern district of that county. In the west, it commences between the town of Dunbarton and the village of Drymen, and stretches from thence towards the east and north-east; in which direction, it is about twenty-two miles in length, but in its breadth it is variable. About the centre of the district, it is nearly ten miles broad, and this breadth diminishes towards its western and eastern extremi-

ties. It is bounded upon the south by Dunbartonshire; and, on the north, by a lowly undulated tract of ground, stretching from the village of Drymen to the town of Stirling, which tract forms the southern part of the river district of the Forth.

The general surface of the Campsie district, may, in the strictest language, be denominated highly undulated. Its surface majestically portrays the Bay of Biscay after a western gale, and its high undulations follow each other in regular succession. These undulations are of great length from south to north, and, nearly in that direction, the most of them stretch from side to side of the district. The general contour of these lengthened hills, individually, is somewhat uncommon, although not peculiar to that part of the country. Each hill has a considerable degree of curvature, the convex side of which, is uniformly presented to the west: the central part of that curve, forms the highest point of their elevation, and they gradually slope towards the extremities of the segments which their curvatures form. Upon their eastern sides, they rise with an equal acclivity of from twenty to thirty degrees; the rapidity of which, in some degree, diminishes as it approaches the summits, where they are somewhat roundbacked. Their central or highest points seldom or ever exceed an elevation of from twelve to fifteen hundred feet above the level of the sea; at which height, their western faces very generally

become abrupt and broken, and continue to be precipitous for a considerable depth under the lip of the hill; but these broken and abrupt faces seldom shew more of the stratification than that of the trap, which in such situations evidently points out its strong tendency towards columnar form. At the bases of these precipices, a long and rapid slope of debris succeeds, which are frequently covered by vegetation. The troughs or hollows between the undulations, generally form narrow dales or glens, but some few of them have a sufficient breadth to entitle them to the denomination of valleys. The most extended of these, are the vales of Campsie, and of Fintry.

Such is the general contour or outline of the surface of this district, with only one or two exceptions; the most prominent of which, is a hill of somewhat conic appearance, called *Meikle Ben.* This hill is situated a little to the south of the road which leads from Fintry to the vale of Campsie. It towers above all the other heights of the district, and rises superior to them at least 300 feet. As far as the interior of this hill can be examined, it is found to be composed of the same species of trap which is so generally the incumbent stratum of the Campsie district. From the base of this hill, issue the rivers of Carron, and of Endrick; the first of these takes an eastern direction, and empties itself into the Frith of Forth; the second takes a western direction, and flows into Lochlomond. This circumstance of the

two rivers rising nearly at the same point, and immediately flowing in directions diametrically opposite to each other, sufficiently ascertains that this hill of Meikle Ben forms the saddle of this part of the country.

I shall now proceed to describe the interior structure and composition of this hilly district.

As far as this tract of country has been dipped into, the geological materials of which it is formed are as follow: A surface of vegetable soil,—trap,—sandstone,—limestone,—shale or slate-clay,—blue clays of various tints and of various consistences,—bituminous shales,—clay iron-ores, some of which are thinly stratified, and others are imbedded in the shale in lenticular forms,—coal,—and clay-marl; all of which materials, have been arranged by nature in the order in which they are here placed, from the surface-soil downwards.

The *vegetable surface-soil* of this district, is but thinly scattered over the face of its hills: it consists mostly of an argillaceous matter of a light brown colour, much mixed with the small debris of the trap on which it generally rests, and from the decomposition of which it has evidently originated. The quantity of iron in this soil is considerable, and it owes its colour to an oxide of that metal.

The rock which occurs immediately under the surface-soil, is *trap*, which generally, in this district, is of great thickness, and, in the broken

western faces of the hills, it frequently shews this thickness in sections of from 70 to 100 feet, perfectly perpendicular to the horizon. These faces almost always display an arrangement of polygonal columnar forms, which generally rest upon sandstone: But, in some instances, I have observed this great body of trap divided into two beds of nearly equal thickness, the upper bed shewing distinctly its strong tendency towards taking columnar form; but the under bed, upon which these columns stand, being perfectly amorphous, and shewing no tendency to any form whatever. The columnar forms of the trap in the upper bed, although clearly apparent, are very irregular in their constructions, as to size, sides, and angles; no symmetrical similitude is to be observed among them. They have in general from three to six sides, and are of various diameters, from one to seven feet. Their heights, at Murray's Hall, may be traced, in the front of the precipice, from seventy to eighty feet, and their positions are in general vertical. Some of these columns appear to be jointed, but these apparent joints have no regularity in position or direction; and these appearances seem only produced by accidental cracks which cross some of the columns. The amorphous part of the trap, which sometimes is interposed between the columnar trap and the sandstone, is of the same composition as the upper bed, but their component parts differ in their proportional quantities; that is to say, that the under

bed contains a much greater proportion of iron than the upper does, and their quantities of hornblende and felspar also vary. When both of those beds are equally exposed to the external air, the under one is seen to be much more under the influence of decomposition than the upper one.

This rock is the Flœtz-Trap of Werner; its composition consists of hornblende, compact felspar, a few scales of mica, some minute portions of iron-pyrites, with an admixture of ferruginous particles, which, in the columnar part of the rock, seem to be but slightly oxidised.

The *sandstone* of this district forms a very general part of its geological composition. The small quantity of cement, which is one of its component parts, and is the cause of the cohesion among its particles, is a white clay, which entitles it to the denomination of an Argillaceous sandstone. The thickness of the various beds of this rock here, is very unequal, and the layers of its strata are from three to eight feet thick. The upper stratum of this sandstone, upon which the trap rests, is generally of a whitish-grey colour; but, in passing downwards, it becomes in colour a whitish-yellow, which at last tints down to a yellowish-brown, from a slight admixture of iron in its cement. Its granulations of quartz are small, and its texture is rather compact; but the adhesion among its particles, is in general by no means strong.

Limestone also forms here a very general part of geological composition: it is found in almost every part of this district, and occurs in separate beds, which are, as to depth, considerably removed from each other. In the eastern part of the district, this limestone is found in two separate beds; the upper one of which varies in thickness from two to four feet, and is one hundred and seven feet under the surface. The second bed has generally a thickness of six feet, and is one hundred and twenty-five feet under the surface. This last bed is in many places extensively wrought by mining; it produces lime of an excellent quality. The limestones of these two beds, are both of a dark bluish-grey colour; they are of a glimmering lustre, and are opake. Their fractures are small splintery, and are somewhat brittle; they are nearly semihard inclining towards soft. Small portions of iron-pyrites and minute petrifactions of entrochi, are imbedded and thinly scattered in their masses. Both of these beds are much intersected by narrow veins of bluish-white calcareous spar.

The *clays* of this district are generally of a dark blue colour, and remarkably tenacious. The shales or slaty-clays are from a dark blue colour to almost that of black; in some places, this shale admits into its composition a small proportion of bitumen and particles of coal-glance. They are of various indurations from very soft to hard. The intervening strata between the two beds of

limestone consist of sandstone, clay, shale, &c.; for the natural position of all of which, see the list of strata and the section.

Iron-ore is plentifully produced in many parts of this district, and it consists of two kinds. The first is found in thin strata, the beds of which are from four to fourteen inches thick; and these beds are separated from each other by layers of blue clay strongly tenacious. The second kind is the lenticular shaped or ball-formed iron-ore, which is found imbedded in blue clay, and also in shale, generally in the near vicinity of coal. Upon the southern confines of this district, in the parish and vale of Kilsyth, I examined with much attention one of the mines which is remarkably productive of this lenticular formed ore. I there found the balls imbedded in a soft shale, and regularly arranged in strata; they rest upon one of their flattened sides, and their distribution is nearly lineal; but in these lines, they are seldom imbedded so near to each other as to come in contact. The balls of each line were generally of the same size. In the deepest strata, the largest balls are found, and the smaller-sized ones are found in higher strata. The largest which I measured, somewhat exceeded a foot in diameter, and they diminish from this size down to a quarter of an inch.

The interior arrangement of these lenticular forms, is so well known, that no description is here necessary; they have, however, afforded a field for considerable discussion, and proofs to aid

theory have been endeavoured to be drawn from their interior appearances. The metal produced from this lenticular ore, is far superior, both in quantity and in quality, to that which is extracted from the ore that is found thinly stratified.

Coal is very generally found around the whole of the border of this district, excepting upon its northern side; and I have little doubt, but that the whole of the Campsie Hills are incumbent upon a coal-field. This, however, remains to be proved, as no coal has as yet been attempted to be found in the central part of the district, where the vast thickness of the trap stratum proves a bar to making trials of that kind at a moderate expence. Towards the western border, in the parish of Campsie, and at the eastern extremity of the district, in the parish of Larbert, coal has been long and extensively wrought. Coal has also been long wrought upon its southern basis, where its hills dip into the vale of Kilsyth. The beds and seams of coal that have been already wrought, are of various thicknesses in various situations; but none of them exceed four feet. Their depth under the surface-soil, varies from seven to twenty-two fathoms. This coal is by no means of the best quality: it is very generally found to contain a considerable quantity of sulphur, and its bituminous ingredient is far from being ample. In burning, it emits a disagreeable smell, and leaves a very large proportion of ashes.

Its roof, or immediate covering in the stratification, and its floor, or what it rests upon, consist both of clay, with which the coal is much mixed, and of course much contaminated.

The general dip of the whole of the strata in the Campsie Hills district, is to the south-east, varying in different places from an angle of sixteen, to one of thirty degrees.

The following is a Table of the Strata as they occur in the eastern part of the district at Murray's Hall, where the trap displays a perpendicular face, of from seventy to eighty feet; and a Table of the Strata near its western extremity, in the vicinity of the village of Campsie, where the coal is found in its greatest thickness.

Two sections taken, one at Murray's Hall, and the other near to the Village of Campsie.

The strata at Murray's Hall.	Feet in thickness.	The strata near the village of Campsie.
1. Vegetable soil, about	2	1. A thin vegetable soil.
2. Trap, columnar, -	60	2. Blue clay mixed with water-worn stones.
3. Trap, amorphous,	16	3. Sandstone.
4. A narrow line of trap much decomposed,	2	4. Slaty-clay, soft.
5. Trap, compact, -	3	5. Sandstone.
6. Sandstone, -	3	6. Slaty-clay, indurated.
7. A narrow strip of slate-clay.		7. Dark bluish-grey limestone.
8. Sandstone, -	8	8. Slaty-clay with lenticular iron-ore.
9. Slate-clay, -	6	9. Coal.
10. Dark bluish-grey limestone, -	3	10. Slaty-clay.
11. Slaty-clay, mixed with glance-coal,	4	11. Slaty-clay, mixed with calcareous matter.
12. Sandstone, -	13	12. Limestone, somewhat lighter in colour than No. 7.
13. Slaty-clay, containing narrow lines of sandstone, -	8	13. Clay-marl.—The miners here have never penetrated as yet to the bottom of this stratum, and the thickness of each stratum in this section was not ascertained with a sufficient degree of accuracy, to be mentioned here. The coal, No. 9., is four feet thick.
14. Slaty-clay almost black,	17	
15. Dark bluish-grey limestone, with entrochi and small particles of pyrites imbedded,	6	
16. Bituminous shale passing into slate-clay,	6	
17. Bituminous shale, with a mixture of calcareous matter and pyrites. The thickness of this stratum not known.		
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In the above section at Murray's Hall, the coal has not yet been found, and by the other taken near to the village of Campsie, the trap does not exist; but this last-mentioned section was taken in one of the vales, in which situations, the trap sometimes disappears, and these disappearances seem, in a great measure, to have been effected by the attrition of rock masses, set in motion by heavy and rapid currents of water.

In all situations of this district, where the trap has disappeared, the vegetable or surface soil rests upon a strongly tenacious blue clay, much mixed with water-worn stones, and this blue clay rests upon sandstone. Among the water-worn stones imbedded in the clay, I seldom found specimens of the native rocks of the district; those which I examined, consisted mostly of rocks generally deemed of the oldest formations, such as quartz, porphyries, granites, &c.; the native beds of which, are far distant to the north and west of that part of the country.

I have here mentioned above, that the disappearance of the trap in some of the glens and narrow vales, seems to have been produced by the effects of the attrition of heavy bodies set in motion by a great force of water in rapid movement. But this hypothesis requires explanation, and an exposition of the phenomena upon which it rests. These, I shall here endeavour to describe, as they appeared in some parts of this district.

In some of the glens and narrow vales, where the trap had not entirely disappeared, I perceived upon its surface strong indications and marks of attrition. In some places the surface of the trap was smooth, and had evidently received a considerable degree of polish; and this polish is almost always seen marked by long lineal scratches. In other places, there appeared narrow grooves, apparently formed by the rapid movement of large masses of rock having been swept along its surface; and I remarked, that these striæ or scratches, were very generally, in a direction from west to east, excepting where inequalities of the surface, and sudden turns in vales had partially influenced the course of the current. In the eastern part of the district, there occurs a small elevated plain slightly undulated. Here the surface of the trap, in some places, had lost its covering of soil, and was left bare for inspection. Upon this plain, I again detected some of these scratches, which were, in this situation, generally in a direction from west to east, sometimes deviating a little towards the south-west and north-east, and sometimes towards the north-west and south-east; but in taking the average or medium of these directions, their general and true course seemed to me to be from west to east. Upon the surface there were scattered immense masses of the trap, which, from their apparent weight, seemed perfectly capable

of forming these scratches and grooves above described, had they been put in motion and impelled along the surface. Upon examining some of these huge masses, I found their surfaces scratched and worn in such a way as to prove sufficiently indicative to me, that they had been long subjected to attrition in water; and I also observed, that many of them presented their principal or most projecting angle towards the west, and sometimes towards the north-west, which, according to my opinion, strongly implies the direction of the current which left them in the position in which they now rest. It is not the object of this paper to dip into the causes of this phenomenon; but that such currents as were capable of the effects which I have endeavoured to describe, have flowed over the surface of our globe, is to me, clearly evident, and these scratches and grooves here mentioned, are some of the minor, but clear proofs of its action. To examine upon the great and true scale the proofs of these currents having existed, we must, in Scotland, enter among the Grampians; and we will there see, that the mountains of that range *very generally* present their most bluff and abrupt sides towards the west, and the north-west points, and tail and taper away towards the east and south-east.

The above observations relative to this subject, may to some appear trivial and unimportant; but

I have here given them, as they relate to a phenomenon, which, I think, merits some attention, especially when the various changes that have taken place upon the crust of our globe, are taken into consideration.

By the description here given of the general stratification of the Campsie Hills district, it will be perceived, that it presents nothing peculiar or very remarkable among its various strata, and is in a great degree similar in its formation to most of the coal-fields in Scotland. I may, however, perhaps be here permitted to except one dissimilarity,—which is the immense bed of trap that is so generally the superincumbent stratum of this portion of the country. From the general configuration of this trap into columnar forms, it will be deemed by some geologists to be of volcanic origin, or that these forms have been produced by the effects of internal heat. In consequence of the writer of this memoir having examined much of Mount Etna from base to summit, and having been frequently upon Vesuvius, as also having visited some of the Lipari Islands, he may perhaps be allowed to have gained some knowledge regarding the apparent effects of heat upon fossil bodies; and, assuming upon this knowledge gained by his frequent visits to volcanic regions, he proposes to venture here some opinions upon this controverted subject; and, in doing so, he must commence by

stating, that, in the district above described, he could perceive no effects either as to matter or form, that might not have been produced by atmospheric action alone; nor could he perceive any appearances in the various strata that occur under the trap, that indicated in any degree, interior heat having ever acted upon them. It is well known, that with regard to geology, there are two systems very different from each other, and by the tenets of these systems, they are widely separated. The adopters of these systems are in general keenly bent towards their support, and fiercely argue upon the propriety of their different creeds.

One class of those philosophers, hold, that the polygonal forms which have been here described as belonging to the Campsie Hills district, are of aqueous origin; and some of this class, even go so far as to say, that the columnar forms found so frequently in the vicinity of volcanic regions, have not assumed that form in consequence of volcanic fire, but that such columns have been only detached from their interior native rocks by the violence of volcanic shocks, and have been ejected in their native state unchanged by volcanic fire.

The other class of philosophers, hold these forms to have been produced by the agency of volcanic fire, or from internal heat proceeding

from some other cause. This last-mentioned class, do not, however, (as is generally thought,) hold all the formations of the crust of our globe, of which we can claim acquaintance, to be of igneous origin: they admit clearly that some of the strata have been formed by a deposition from water; but for the *consolidation* of these strata so formed, they think it necessary to call in the aid of internal heat, and hold these polygonal forms to have been produced in consequence of its effects. Such, upon this point, is nearly the general outline of the difference of opinion subsisting between these two parties. But it ought to be remembered, that nature frequently produces the same effects by very different means, and that the columnar configurations are formed not only in the *moist* but also in the *dry* way; which can be here easily exemplified. The aqueous origin of these forms, may be observed upon any extended surface of clay or of mud, which has been the deposite of water, and where evaporation has taken place. In such situations, when evaporation has taken place to a considerable degree of dryness, the deposited soil gradually shrinks, cracks in various directions, and takes polygonal forms. If the soil in such situations is shallow, the *tabular* form is exhibited; but if the soil is of any considerable thickness, the *columnar* form appears. Beautiful displays of these forms on a small scale, may fre-

quently be seen in the operation of starch-drying, and in some of the preparations for pottery.

Upon the large scale, this operation of nature is to be seen to the greatest advantage in warm climates, where evaporation is strong and rapid; one example of which, I shall here beg leave to describe, it having struck me as being a remarkably good and explanatory specimen of this phenomenon. The notes which I took upon the spot where this specimen occurred, are now before me.

In the Mediterranean, on the coast of Africa, this example fell under my observation some years ago. In the near vicinity of a considerable rivulet, deeply imbedded in a soft soil, there had existed a piece of water of considerable expanse, on a level of about twenty feet above the stream of this rivulet; one of the windings of this stream had undermined, and had carried off a great part of a rising ground that had served to imbank upon one side this former lake; which bank, when broken down, had given drainage to it, and had laid open its deposited soil to a considerable depth. Upon this broken down side, the soil of the former lake displayed a beautiful arrangement of columnar forms. These were in length about eighteen feet, and were from a foot and a half to three feet in diameter, but, as to their magnitudes and forms, they varied much from each

other; although, however, there was no very striking similarity to be observed among them, they were all angular, and their forms generally consisted of four, five, and six sides. They were perfectly vertical in position, and their forms were to be traced nearly down to the stream which had invaded their situation. Upon examining the surface which the lake had formerly covered, I found it perfectly level, and divided into polygonal forms by fissures and cracks, stretching out in all directions, which, by intersection, formed the columns here described; on the tops of which, I stepped from column to column, as upon a Giant's Causeway. Some of the cracks and fissures had been here filled up with dust of a blackish-brown colour, which gave some parts of this surface the appearance of mosaic work. The majority of the tops of the columns were certainly very irregular as to form, yet there were some among them that could be perceived approaching very nearly to regularity in sides and angles: two of these particularly attracted my attention, and which I found almost bore the test of measurement. These two were pentagons; the one was two feet, and the other a foot and a half in diameter. The muddy clay of which the whole of these columns were composed, was almost of an impalpable grain, and was of a reddish-brown colour; it had gained a considerable induration in

the mass, but could be easily scratched by the nail. This example is drawn from classic ground: I discovered it in the vicinity of ancient Carthage, where debris now only mark the former site of that great and important city.

Those geologists, who, upon the other hand, assert, that columnar forms are not produced by volcanic operation, must surely have never visited a real volcanic region. Proofs of this form having taken place in consequence of volcanic agency, are to be seen around the sites of almost every volcano where lava has been erupted. I shall, however, not now take up the time of this Society longer, than by giving one of the many examples that I could bring forward in proof of this assertion being well founded; and this example I shall draw from a subject which cannot bear a dispute as to its being of volcanic origin; and which, according to my opinion, will alone prove decisive.

The Eolean or Lipari Islands, are clearly ascertained to be of volcanic origin; the greater part of them have been visited by men of science, who, from their geological knowledge, were perfectly adequate to ascertain of what materials they are formed, and to describe those materials scientifically. Felicuda, is one of the most western of this group of islands. It is generally reckoned from eight to nine miles in circum-

ference, and is entirely formed of lava and other volcanic productions. In the interior of this island, there is a mountain of considerable height, upon the summit of which may be traced the principal crater of this now extinguished volcano.

The form of this crater is a regular cone inverted, and its lip nearly measures half a mile in circumference. From this mouth, and from its sides, have flowed many streams of lava, some of which may still be traced in various directions. Where these streams had flowed over planes slightly inclined, their surfaces in general continued to be tolerably smooth ; but where descents were more rapid, there in many places, the surface-crust of the lava had burst, and in such a situation, it presented a broken, rough, and rugged appearance.

One of these streams of lava, I was enabled to trace until it arrived at the verge of the island, where it had dropt into the sea over a lava rock nearly perpendicular, and which rose from the level of the water to a height of not less than from sixty to seventy feet. The lava here, even after it had passed over the verge of this precipitous declivity, still retained for a short distance a considerable degree of smoothness, but which was soon broken in upon by narrow longitudinal furrows appearing upon its surface. These lines at

first, only slightly marked their directions; but, as they descended, they became deeper and deeper, until their interstices began to assume an approach towards form, and near to the water, these forms were seen perfectly columnar. At this place, the columnar forms thus produced, by the congelation and shrinking of the lava, had generally three, and some of them four sides; one of which sides, always continued attached to the amorphous mass of lava from which the column had shrunk. Upon some other parts of the shores of this island, I observed these forms arrested in various stages towards complete columnar shape. In some of those situations, the striæ or lines had only appeared, in others, form was slightly indicated; in some places they were seen half formed, and in others, their formation was complete.

Upon the sides of the island, where these forms occurred overhanging the sea, I observed that they seldom or ever arrived at a full completion of their figures, until they approached nearly the surface of the water, and they continued perfect in form as far under the surface of the water as I could distinguish them with my eye. The columnar forms which I saw upon this island, were in general four-sided, but there also occurs among them many of three, and some of five sides; but those last of pentagonal form, are rare. The general run of their diameters seldom exceed two feet.

In one part of this island, I discovered a great accumulation of fragments of obsidian and of pumice; but these are two substances, which some geologists will not admit to be of igneous origin. With regard to this point in dispute, I must here repeat what I have already observed in another part of this memoir, that those who hold obsidian and pumice not to be of igneous origin, most certainly can never have trod true volcanic ground. Proofs of these two substances being of igneous origin, are to be seen upon Etna, Vesuvius, and upon some of the Lipari Islands; and those proofs which I have there seen, appeared to me so evident, that their origin could admit of no dispute. One or two examples of these proofs, I shall here beg leave to give, by copying some of the notes which I took while on the Island of Felicuda. Near the centre of the island, somewhat to the south-east of the principal mountain which I have had already occasion to mention, I discovered the remains of a crater upon an insulated hill, which I found entirely formed of different coatings of lava of various thicknesses. In two different currents of the lava proceeding from the broken crater of this hill, I observed obsidian which had been in flow with the lava, and now formed part of its congealed stream. This obsidian when in mass, appeared almost black and opake; but, at the edges of its beautiful conchoidal fracture, it was in some degree trans-

lucent, and there shewed a muddy-brown colour. In some parts of this obsidian, it is seen deviating from its brilliancy, and from its compact vitreous texture, and is evidently seen passing into a granular lava; but the marks of this gradual transition are soon lost, and the lava into which the obsidian had passed, is then not to be distinguished in colour, in fracture, nor in texture, from the general lava of the other parts of the stream. Where this obsidian appears in mass, and in a state of perfect glass, it is very near to where it has been first ejected from the side of the crater, and in a situation where it must have undergone a rapid cooling. In some parts of these congealed streams, I could trace a transition of the obsidian into pumice. In those places, the obsidian was seen to contain scattered air-globules, which were almost always lengthened in the direction of the stream. These globules gradually augmented in number until the whole of the substance became a light, fragile and frothy pumice.

At the place where I discovered the great accumulation of obsidian and pumice, mentioned above, I saw and obtained many specimens of all the transitions here described. In the various streams of lava which had flowed from the principal and central crater of this island, I found many indications of pumice, but none of obsidian.

The above observations relative to some of the facts and tenets connected with the two theories in geology, which are so much at variance with each other, are certainly in a great degree foreign to the greater part of the subject which this paper was originally intended to embrace. But having, in the first part of this memoir, carefully avoided mixing *description* with *theory*, and as a phenomenon occurs in the district described, which is one of the controverted points, I have presumed to lay before this Society a few of the facts which relate to both of the theories, and which consist of those alone which have fallen under my own observations when visiting various parts of the globe; but, in doing so, I am afraid, that according to the opinion of some, and perhaps according to my own, I have been led into a digression, which I have made too multifarious, and considerably too long; for which I here beg leave to apologize.

I, however, cannot here refrain from adding one more observation relative to an extreme bad effect which a violent support of theory in geology leads to, and which I am certain, must have been observed and regretted by all impartial geologists. Where the too keen and extravagant support of theory has crept in, and where prejudice has taken root, we must bid adieu to all candid geological description. Not that I here mean to allege, that all describers of geological scenery, un-

der these influences, would intentionally mislead; but many of them stray into error without they themselves being aware of their giving false description. Their minds are warped without their knowing it; and their jaundiced eyes see all objects around them yellow, and they describe accordingly. Reasoning and argument may then be dropt; as the strongly prejudiced mind is not to be convinced, even by a clear demonstration of truth.

Explanation of Plate I. *giving a view of the Strata at Murray's Hall, Campsie Hills.*

No. of the strata.	Colour.	Feet thick.
1. Surface soil.		2
2. Trap, columnar.	Lead-grey.	60
3. Trap, amorphous.	Rusty greyish-brown.	16
4. A narrow line of trap much decomposed,	Ochry brown.	2
5. Amorphous trap, very compact.	Dark blackish-grey.	3
6. Sandstone.	Light greyish-white.	3
7. A narrow strip of slate-clay.	Greenish-grey.	
8. Sandstone.	Pale ash-grey.	8
9. Slate-clay.	Common lead-grey.	6
10. Limestone.	Bluish-black.	3
11. Slate-clay, mixed with glance-coal.	Greyish-black and rusty-orange.	4
12. Sandstone.	Pale yellow.	13
13. Slate-clay, containing narrow lines of sandstone.	Blackish-grey with bluish-grey lines.	8
14. Slate-clay.	Blackish-grey.	17
15. Limestone, containing entrochi and specks of pyrites.	Bluish-black.	6
16. Bituminous shale passing into slate-clay.	Blackish-grey, with a tint of green in it.	6
17. Bituminous shale, containing calcareous matter. The thickness of this stratum is not yet ascertained.	Blackish lead-grey.	
No. 18. is the entrance to the mine by which the limestone No. 15. is wrought.		
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III. *Chemical Analysis of a Specimen of Magnetic Iron-Ore from Greenland.*

By Thomas Thomson, M. D. F. R. S. L. & E.

(*Read 9th March* 1811.)

As iron is scattered over the surface of the earth in greater profusion than any other metal, and as it is very easily acted upon and altered by the action of the air, of water, and of a variety of other agents, we need not be surprised that the number of its ores is very considerable. It is from these ores that the metal is extracted; and it has been observed, that the quality of the iron obtained, very much depends upon the nature of the ore which has been employed in the manufacture. Some varieties of iron are much brittler, much weaker, much tougher, much more ductile, &c. than others. These differences undoubtedly depend upon the foreign substances which happen

to exist in the iron-ores, and which the imperfect processes of the manufacturers do not enable them to separate. Hence the analysis of the ores of iron comes to be an object of very great importance; as it is the only method of acquiring a knowledge of the nature of the foreign substances which alter the nature of iron. Were they once accurately known, it might be possible to vary the processes of the manufacturers, so as to enable them to get rid of these foreign substances altogether, and thus make all iron of exactly the same quality: or it might be possible to substitute those which are least injurious for those which are most injurious, or, by introducing at once two foreign substances of opposite natures, to neutralize the effect of both.

Magnetic iron, which constitutes the subject of this paper, is one of the most abundant and important of all the iron-ores. It has been usually conceived to consist of pure oxides of iron, and to this purity, the goodness of the iron obtained from it has been ascribed.

The only chemical experiments on this ore, with which I am acquainted, were made by Bucholz *. He ascertained the action of muriatic and sulphuric acids upon it, and concluded from his experiments, that it was a mixture of black and red

* Gehlen's Journal, 2d series, vol. iii. p. 106.

oxides of iron, with a little siliceous matter, in the form of grains of quartz.

The specimen on which the following experiments were made, was found in a Danish vessel which had been brought as a prize to Leith. A collection of minerals was found on board this vessel, which, from the abundance of cryolite that it contained, was supposed to have been made in Greenland. This collection was purchased by Mr Thomas Allan and Colonel Imrie, and is remarkable for containing two new species of minerals, to which the names of Allanite and Sodalite have been given.

The appearance of common magnetic ironstone, is so well known, that any description of it would be superfluous. The specimen examined, was massive; of the specific gravity 4.7619; and had a variety of phosphate of lime adhering to one of its sides.

Sulphuric acid has but little action on this ore, though, by the assistance of heat, an imperfect solution may be produced. With muriatic acid, it effervesces very slightly when previously reduced to a fine powder; and by long digestion on a sand bath, a complete solution may be obtained, with the exception of a white powder, which amounts only to a small quantity.

If the white powder remaining undissolved be digested for several days in muriatic acid, the liquid becomes milky, and passes in that state

through the filter, so that the milky matter cannot be separated. But by spontaneous evaporation, a small quantity of whitish matter was procured; which, after being heated to redness, became insoluble, though it gave out a little iron when digested in muriatic acid. It was heated to redness with four times its weight of carbonate of potash. The mass was then digested in water. By this means, a white powder was obtained. This white powder dissolved in muriatic acid. The solution was yellow, and, when treated with reagents, exhibited the following appearances:

1. With infusion of galls, a reddish brown precipitate fell.

2. Prussiate of potash. A blue precipitate, which became white when a little ammonia was added.

3. Hydrosulphuret of ammonia. A dark green precipitate in flocks.

4. Ammonia. 5. Carbonate of soda.	A white flocky precipitate.
6. Phosphate of soda. 7. Arseniate of potash.	A white flocky precipitate.
8. Oxalate of ammonia. 9. Tartrate of potash.	No change.

From these experiments it follows, that the substance was white oxide of titanium, not quite free from iron.

After all the titanium had been separated from the insoluble part of the ore, there still remained a small portion of white matter. It was fused with potash,—softened with water,—neutralized with muriatic acid, and then evaporated nearly to dryness. It assumed the form of an insoluble jelly. Hence this insoluble portion was silica, not, however, quite free from iron, for it was slightly coloured.

Such was the process followed in the analysis, and such the substances obtained: 100 grains of the ore being treated in this manner, yielded 126.5 grains of red oxide of iron, 4.2 grains of white oxide of titanium, and 2.4 grains of silica.

From the great quantity of red oxide obtained in the present case, it is obvious, that the ore is not a mixture of black and red oxides of iron. Had it consisted of black oxide alone, the quantity of red oxide which it would have yielded, would have been less. The only possible conclusion, is, either that the iron in magnetic iron-ore is a mixture of iron in the metallic state, and of black oxide of iron, or that it is in a state of oxydizement different from any at present known, and in which the metal is combined with less oxygen than in black oxide.

Theory would lead us to conclude, that iron is capable of combining with three different dozes

of oxygen, and of forming three oxides; the composition of each of which, is as follows:

	Iron.	Oxygen.
1. Protoxide, composed of,	100 +	15
2. Deutoxide, -	100 +	$15 \times 2 = 30$.
3. Peroxide, -	100 +	$15 \times 3 = 45$.

The second and third of these oxides are known. They are the common black and red oxides of iron. But we remain still unacquainted with the first, which cannot be formed artificially by any known process.

It is by no means an unlikely circumstance, that magnetic iron-ore consists chiefly of this hitherto unknown protoxide. It differs in its properties from black oxide, being more soluble both in sulphuric and muriatic acids, and effervescing slightly during its solution, which is not the case with black oxide. The circumstance also of its being at least occasionally a permanent magnet, ought not to be overlooked. Pure iron possesses this property in a very trifling degree. Mr Hatchett has shewn, that iron may be converted into a magnet, when combined with a minimum of carbon, sulphur or phosphorus, but loses its magnetic virtue entirely when saturated with these substances. It is not unlikely that the analogy may be extended to oxygen likewise. Red oxide of iron is not magnetic at all: black oxide is im-

perfectly so: magnetic iron-ore being so in a great degree, since the substance distinguished by the name of magnet belongs to it, is most probably composed chiefly of protoxide of iron. This, at least, is more likely, than that it should be a mixture of metallic iron, and black oxide of iron, the only other supposition which it is possible to form.

IV. *Description of a Swordfish found in the Frith of Forth in June* 1811.

By William Elford Leach, Esq; F. L. S.—W. S. &c.

(Read 27th July 1811.*)*

Xiphias *Rondeletii*.

Pl. II. Fig. 1.

X. Corpore sub-scabro, linea laterali nulla; pinnis dorsali analique interruptis.

Long. Corp.—rostro incluso, *Ped.* 8. *unc.* 3.

Habitat—in mare Britannico, piscibus minoribus victitans.

Descr.—Rostrum compressum, suprà trisulcatum nigrum, infrà sub-carinatum albicans. Oculi sub-argenteo-viridescentes, pupillo pulvinato-albicante-cœruleo-atro. (Membrana branchiostega 5-radiata?) Derma sub-scabra, *dorso* nigricante, *ventre lateribus*que, argenteo-albis. Pinna *pectoralis* argentea, præter marginem anticam suprà quæ nigridine gaudet. Pinna *dorsalis* nigra, interrupta, intervallo exarato. Pinna *analis* cœruleo-nigra interrupta. Linea *lateralis* nulla.

The specimen from which we drew the above description, was taken by some fishermen at Queens-

ferry, and purchased by Mr Macintyre, merchant, who sent it to Edinburgh, where it now is, having been stuffed under the care of Mr Wilson at the College. On dissection, it proved to be a female, and in the stomach the remains of small fish were discovered.

Two other specimens of Xiphias, probably of this species, are recorded by naturalists, as having occurred on the British shores; one by Sir Robert Sibbald; the other by Pennant, as having been washed ashore at Langhearn in Carmarthenshire. The figure of the latter author, I suspect, has been depicted by the fancy of the ignorant artist he employed, to whom the public are also partly indebted for the Trifurcated Hake, an animal lately proved, by the accurate Donovan, never to have existed. The only figure to which we can refer with any confidence, is that given by Rondeletius, who, however, has omitted the posterior anal fin: but it agrees in other points so well, that I have named it, in honour of him as the first discoverer, XIPHIAS *Rondeletii*.

The head was much lacerated: I therefore suspect that part of the branchiostegous membrane has been torn away; this, however, future observations will decide. The superior process of the tail was also incomplete, although there can be little doubt, from what remains, that it was considerably larger than the lower part.

Since the above was written, I have been informed by Mr Bullock, that, some years since, he saw in the Frith of Forth several living specimens of a Xiphias playing in the water; I think he said seven or eight, and he was so near as to be enabled to observe the dorsal fin to be undivided. It is therefore highly probable, that Xiphias *gladius* may also be a native of our seas, or perhaps be the other sex of this.

V. *Some Observations on the Genus* SQUALUS *of Linné, with Descriptions and Outline Figures of two British Species.*

By WILLIAM ELFORD LEACH, Esq; F. L. S.—W. S., &c.

(*Read* 18*th January* 1812.)

No family of the Amphibia, is in greater confusion, or wrapped in such obscurity, as the SQUALINIDÆ; the characters which distinguish its genera remaining undefined, and the figures of species being so incorrectly given, as never to be quoted without doubt. Much, therefore, remains to be done, and I trust that no zoologist will neglect to describe and figure all that may come under his inspection, and communicate his observations to this Society, through the medium of whose *Transactions* we may hereafter hope to be made acquainted with such species as are found on our coasts. The principal characters which distinguish the species, may be drawn from the nose, neck, and fins, and probably from the colour as well as

shape of these parts: The generic characters from the teeth, the position and form of the mouth, and of the sacral fin. Two genera have been formed from the Linnean genus, viz. SQUATINA and SQUALUS. To these I shall beg permission to add two more, as in the following Table:

Familia SQUALINIDÆ.

* *Pinnâ anali*

1. Pinna caudalis lunata,	-	SQUALUS*.
2. Pinna caudalis irregularis,	-	GALEUS.

** *Pinnâ anali nullâ.*

3. Os ante oculos situm,	-	SQUATINA.
4. Os pone oculos situm,	-	ACANTHIAS.

A more minute division, will, I have little doubt, be hereafter found necessary; but, in our present state of knowledge, I should not consider myself justified in proposing more genera. The sexes of the genera SQUALUS and GALEUS, may be distinguished from the ventral fins being either entire, divided, or furnished with a long process beneath.

* This genus may be subdivided from the structure of the teeth.

GALEUS *Mustelus*.

Tab. II. Fig. 3.

G. Dorso plumbeo-nigricante; ventre sub-argenteo albido.

Γαλεος, *Arist. Hist. anim.* vi. c. 10.
GALEUS lævis. *Rond. de pis. mar.* 375. *cum icone.*
MUSTELUS lævis primus. *Will. Icth.* 60.
Smooth *or* unprickly hound. *Raj. Syn. pis.* 22.
SQUALUS mustelus. *Linn. Syst. Nat.* 400.
Gmel. Syst. Nat. 1492. 13.
Smooth shark. *Penn. Brit. Zool.* 3. 116. tab. 16.
SQUALUS mustelus, *or* murloch. *Neill, Wern. Trans.* vol. i. p. 549.

LONG. CORP.—Pedes sex.

Habitat—in Oceano Europæo.

Descr. CAPUT acuminatum sub-rotundatum. PINNÆ *pectorales* suprà nigricans, parte inferiore marginibusque posticis albis. PINNÆ *ventrales* et *anales* albidæ. CAUDA sub-fusco-nigricans, margine inferiore griseo-testaceo aut dilutiore. PINNA *dorsalis atlantalis* * sub-plumbeo-cinerascenti-nigricans, margine postico saturatiore, basi anticè posticèque albido. PINNA *dorsalis sacralis* † cinereo-nigricans.

A specimen of this species was taken by the Newhaven fishermen last June, having been accidentally found entangled in their nets; it was a female, and measured from the inial to the sacral

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* Pinna dorsalis antica *auctorum.*

† Pinna dorsalis postica *auctorum.*

extremities, six feet; in the uteri were twenty-six young, agreeing in shape, proportion, and colour with the old one: from one of these, the annexed figure was taken; the description from the adult animal. I am sorry that I neglected to examine the teeth, and cannot but express my regret at such a shameful neglect, for which I can find no excuse. The skin of the old and young was very rough, as is the case with all the other species which have come under my inspection: the term *lævis*, was therefore applied by the older writers, to distinguish it from the piked dogfish of the fishermen, ACANTHIAS *antiquorum*. Mr Pennant says, "The teeth resemble those of a ray, rough and sharp."

SQUALUS *Selanonus*.

Tab. II. Fig. 2.

Teeth in front, six rows, smooth, with two processes on each side at their base.

SQUALUS *Selanonus*. *Walker MSS.*
Mus. Wern. Soc.

The specimen from which the drawing is made, was taken in Lochfyne, and is figured in the MSS. drawings of the late ingenious Professor of Natural History, Dr Walker, from whose sketch, (through the attention and goodness of Professor Jameson, to whom I stand greatly indebted for the as-

sistance he has often rendered me in zoology,) the above name is taken. As the specimen is in a dried state, nothing can be said as to its colour. I may observe, however, that the nostrils are placed on the base of the porrected nose, as may be indistinctly seen in the annexed outline. It may be questioned whether it be an undescribed species. I am of opinion, that it is the Basking Shark of Mr Pennant: it agrees with his description, which was drawn from a recent specimen on the shores of Loch Ranza, Isle of Arran. The figure, it may be argued, is altogether different; but when I inform the Society, that all or most of the figures which disgrace the work of that eminent zoologist, were made by an ignorant artist, and still more stupid engraver, who fashioned the animal to suit their fancy, carefully rounding angles, to give an elegance to their works, the objection will cease. Still, it may be enquired, Is Pennant's basking shark the SQUALUS *maximus* of Linné? or are we to consider that figured by Mr Home in the Philosophical Transactions, as referable to that species? These gentlemen have most clearly described two very distinct species under the same name. La Cepède, in his *Histoire des Poissons*, has figured Pennant's Basking Shark as SQUALUS *maximus* of Linné, calling it SQUALE *très grand*. The length of the specimen of SQUALUS *Selanonus*, which is preserved in the Museum of this University, is about eight feet and a half.

I cannot conclude without observing, that the terms *atlantal* and *sacral*, are applied to the anterior and posterior dorsal fins; although, in this instance, the terms *anterior* and *posterior* would have applied equally well, yet, on other occasions they would be subject to much objection; for the sake of uniformity, therefore, they are used here also. I am happy in being enabled to state, that the anatomical nomenclature of Dr Barclay is adopted by several of the most eminent zoologists in this country, who in future will introduce them into their descriptions, thereby avoiding that ambiguity of language which has rendered nearly useless the valuable works of several older writers.

Since the above was given to the Society, I have been favoured by my worthy friend the Rev. John Fleming, with the jaws of SQUALUS *Selanonus* taken in Zetland, which agrees with that in the Museum of the College.

VI. *An Essay on Sponges, with Descriptions of all the Species that have been discovered on the Coast of Great Britain.*

By GEORGE MONTAGU, Esq; F. L. S. & M. W. S.

(Read 7th March 1812.*)*

LITTLE has been added to the division of *Zoophyta* as British, since the time of that enlightened zoophytist Mr Ellis, to whom we are greatly indebted, not only for the discovery of numerous species of the several genera that constitute this class of animate beings, but for his critical investigation. By his indefatigable researches, microscopical inspection, and judicious dissection, he clearly demonstrated, that the subjects of this division (which had been considered as extremely ambiguous, from their general appearance bearing so much similitude to plants) are truly of *animal* origin. Many indeed, which appear to possess all

the qualities of marine plants, such as roots *, stem, branches, and vesicles bearing the young *in embryo*, like seeds, (as exemplified in *Sertularia,*) are formed for the support of an animal of a most complicated nature. These coverings, or more imperishable parts of *zoophytal* animals, grow in the same manner, and some perhaps draw in nourishment in a similar way, as *fuci* and *confervæ*. Like shells, however, they are constituent parts of an integral animal, expanding with it according to the laws of nature.

The subjects in *Zoophyta*, as in *Testacea*, when examined in the cabinet only, exhibit that part of the animal which is the least perishable; and of course, that, by which science has been best able to define, and reduce them to system, for the better ascertaining the distinction of the numerous species.

It is not, however, my intention to enter into a general history of the nature of *zoophytes* in this place; nor is it required; since nothing further is necessary for those who demand instruction in this abstruse science, than to peruse the works of our countryman Ellis. There are indeed some of the subjects which belong to this class of beings, that possess so small a share of apparent vitality, and are so indefinite in shape, that even

* Radical tubes, or ramifications resembling roots, by which they are affixed to other bodies.

that great illuminator in this science, could not define them: amongst these, *Alcyonium* and *Spongia* seem to rest nearly where they were left by Ellis. Of the former, if we were to confine the genus to an aggregate of polypes, enclosed within superficial cells, (which appears essential,) then several of the species of *Alcyonium* would be removed, particularly *lyncurium*, *cydonium*, *bursa*, and perhaps some others. In these three, no stellate pores or cells, nor polypes, have ever been observed.

Bursa is without doubt a *Conferva*. *Lyncurium* and *cydonium* approach very near to *Spongia*; but these, with two or three others of similar structure, might perhaps be formed into a new genus, if any advantage to science could be gained by it. However, till we are better acquainted with more of this intricate family, I shall arrange two or three of the same structure (which are perhaps new) in the genus *Spongia*, as bearing strong characters of such, according to the Ellisian definition.

The animals of this genus, the most inert and least definable by means of the animal itself, are extremely obscure; consequently it is not sufficient that such anomalous beings be described in half a dozen of words, which is all we have to direct us with respect to many species. In most instances, shape is not to be depended upon; and, as the greater part of the sponges we obtain, are thrown ashore by the sea after storms, few are found

perfect. Those in which we are the least likely to err, are such as are branched, lobated, foliated, or digitated, or possess something like specific characters independent of texture; but, at the same time, texture must be a leading feature in discrimination, for, in the more compact sponges, destitute of ramifications or appendages, and where shape has no uniformity, texture alone must guide our opinion.

Under all the difficulties I have to encounter with respect to synonyma, I am induced to offer an essay on the British species of this intricate genus, for these reasons: *1st*, Because I possess many that do not appear to have been described; *2dly*, Because no British naturalist, since Ellis, has exclusively undertaken the subject; and, *3dly*, Because it may pave the way to greater exertions in this occult science, by stimulating others to reap in the same field, and give their gleanings to the public.

If I fall into error with respect to synonymes, those who have studied the subject will readily excuse it, from their knowledge of the difficulty of avoiding it. If I fail in my endeavours to define all the British species of *Spongia*, I am sure of obtaining two desirable objects;—that of the pleasure and information the study and researches have afforded me; and also that of allowing the scientific to participate with me in the benefit of these researches, which some friends have urged me to publish.

It would appear that Mr Ellis found much difficulty in ascertaining the species of this genus. By him seven only seem to have been described, viz. *coronata, oculata, tomentosa, stuposa, cristata, palmata,* and *botryoides.* In addition to these, Berkenhout has given *dichotoma;* Mr Sowerby, in his British Miscellany, enumerates three others: *pulchella, cancellata,* and *compacta;* and, lastly, we find *infundibuliformis, ventilabrum,* and *compressa,* described as British by Professor Jameson in the first volume of the Memoirs of the Wernerian Society; making together fourteen species.

It will be noticed, that, in the following pages, I have almost twice that number; and of those which possess sufficiently strong specific characters to be defined by the pencil, figures have been given.

With respect to the nature of sponges, there has been considerable difference of opinion; but, in the present era of natural history, it is pretty generally allowed, that they are truly of an animal substance, extremely torpid, and for the most part, if not wholly, destitute of visible motion. With considerable attention to some species taken fresh from the sea, and others that I have examined in the cavities of their native rocks, still immersed in their natural element, not the smallest motion was perceptible, nor were there any appearances of internal action; for such would have produced some

currents or slight agitation in the water, which must have been perceived by the assistance of glasses *. Action, however, is by no means necessary to constitute an animal; for in many instances vitality is known to exist without mobility.

Zoophytes in general are destitute of locomotion; and what action any of them possesses is very limited, being chiefly confined to the multifarious polypi that constitute them. The only genus of *Zoophyta* which is not possessed of polypes, is *Spongia*; and it is to be wished that this character should be continued in contradistinction to *Alcyonium*, which Mr Ellis established as the basis of separation in the two genera.

In the generic characters, Bosc has unfortunately omitted this essential distinction, as he has described both genera to be *polymorphous polypi*, which should imply that *spongia*, as well as *alcyonium*, is constituted by polypes. This is contrary to all experience, and indeed is in direct opposition to fact.

It is not necessary that an animal body should have motion to assure us of its animality, or that it sustains vitality; since life, in some of the lower order of beings, is so infinitely diffused and variously modified; at the same time that animal ac-

* Mr Ellis speaks with certainty as to the contractive and expansive property of one species, the *cristata*.

tion is so extremely limited, as to create doubts of its existence *.

The actual distinction between animal and vegetable life, is perhaps so small and indefinite, that the physiologist will scarcely venture to say where the one terminates, and the other commences: the only material distinction between them appears to consist in their constituent parts.

By chemical analysis, there appears to be an infallible character of specific distinction, by which they are with certainty recognised †. That character, therefore, discovered in all animal matter, has been proved by chemical decomposition to exist in sponges ‡. Motion, as already observed, is not essential to animality; and in their inertion, zoophytes, especially sponges, approximate so nearly to ve-

* Vitality is not affected by separating any part of zoophytal animals, no more than in Hydra: each fraction contains an equal portion of vitality independent of connexion. In the higher order of beings, vitality is limited.

† "I need not," says Mr Ellis, when speaking of the chemical experiments on *keratophyta*, "mention any other to the curious, than the great quantity of volatile salts that may be extracted from them, and the strong smell they yield when burnt, of roasted oysters."

‡ The odour produced in the combustion of sponges, and other zoophytes, is similar to that of other animal substances, mixed with a peculiar marine odour, well exemplified by oysters roasted in their shells; and which is very different from the effluvia of burning vegetable matter.

getables, that it is only the peculiarity of their constituent parts (which we are enabled to discover by the aid of chemical science) that separates them. It is not essential to the formation and growth of animal substance, that a heart, brains, or even intestines, or any viscera, should exist, no more than it is, that all vegetables should possess roots.

Many species of *alcyonium* appear to be destitute of motion except in that part termed the polypi; and yet these only constitute a small proportion of this multifarious animal; for the basis from which these animated portions issue, is equally formed of the same material, also endued with the principle of animal life. Were it not for the multifarious polypi that constitute a part of *alcyonium*, the characters of distinction between that and *spongia*, would be more indefinite.

Whether motion has ever been discovered or not in any species of sponge, is not I conceive of so much importance as some naturalists would appear to consider. Those who are solicitous in their inquiries after the animals which they have supposed to construct the vesicular fabric of sponges, and have expressed their surprise, that in this age of cultivated science, no one should yet have discovered,—must have taken a very limited view of matter possessing vitality, and have grounded their hypothesis only upon supposed analogy. Why should it be concluded that sponges are only the *nidi* of insects or vermes; or why

should not organic matter possessing vitality without action, exist? If these philosophers expect to find polypes, or vermes of any kind, to be the inhabitants of Sponges, they will be deceived. The true character of spongia, is that of a living, inactive, gelatinous flesh, supported by innumerable cartilaginous or corneous fibres or spicula, most commonly ramified or reticulated, and furnished more or less with external pores or small mouths, which absorb the water, and which is conveyed by an infinity of minute channels or capillary tubes throughout every part of the body, and is there decomposed, and the oxygen absorbed as its principal nourishment, similar to the decomposition of air in the pulmonary organs of what are called perfect animals.

The food of sponges must be similar to that of plants; for a Sponge has no more power to digest gross bodies, than a Fucus or a Conferva; and nothing can be more admirably adapted to a gaseous aliment than the construction of a sponge. The conformation of a sponge, better entitles it to the appellation of *sea-lungs,* than any other marine production; since the water absorbed by its capillary tubes becomes as greatly divided, as air respired by pulmonary organs; and thus by such an extensive surface offered to the water, decomposition may be effected in the same way as air is decomposed in the lungs of terrestrial animals.

Having advanced an opinion upon the constitution of sponge, it must be observed, that I have not enumerated what has been usually considered as fresh-water species of this genus, in my catalogue of British sponges, conceiving that they are actually of a different nature. Lamarck has separated these from *Spongia*, and has placed them in a new genus denominated *Cristatella*, which bears evident polypes. Bosc, however, conceives Lamarck has been deceived by a figure in Roesel, as he declares that he has examined a vast quantity of what is called *Spongia fluviatilis*, and never could discover animal organization with signs of life.

Not having had an opportunity of examining recent specimens of these fresh-water species of supposed sponges, I must confess that, by the structure alone in an *arid* state, I am led to an opinion that they do not truly belong to the genus Spongia *.

* This fibrous brittle substance is evidently of animal origin, by its odour in combustion: the numerous minute globules it contains of the same figure and size, interspersed throughout the whole substance, have evident characters of *ova* connected together by glutinous filaments, which form the reticulated mass. If these minute globes were cells of polypes, or any other perfect animal, they would possess an aperture; whereas they have no opening. They are strong, tough, and polished within, like what the remains of a glareous matter would be when dried in

I shall now proceed to give a description of the several species of sponges that have been discovered to inhabit the British Islands.

so small a body. It appears to me, that this substance is in fact the nidus of some aquatic insect, which may possibly congregate to deposite their eggs; and that the fibres, or threads that decussate each other, are attached to the *ova* for their security in mass, as we perceive in those of some spiders and other land insects.

SPONGIA

SPONGIA BRITANNICA.

In order to facilitate the arrangement of the species, I have divided them into the following families:

1. Branched; those which are properly branched, simple or compound.
2. Digitated; those which are divided into lobes or leaves, on their sides or on the summit.
3. Tubular; such as shoot into tubular processes, whether simple or compound.
4. Compact; such as are destitute of any divisions, and are of a compact form, but of indefinite shape, whether of an open or a solid texture.
5. Orbicular; such as are globose, with internal, radiating, asbestine spiculæ.

* Branched.

1. *Oculata.* Much branched, soft, the branches roundish and obtuse, furnished with marginal pores.

Plate vi. fig. 2.

Spongia oculata. *Ellis,* Coral. p. 80. t. 32. fig. F. f.—*Id.* Zooph. p. 390.—*Gmel.* p. 3820.

In all the specimens I have examined, some of the branches originate from the base, but have a

distinct stalk, which is composed of tougher materials, the fibres being ligneous and longitudinal. An elegant variety in my cabinet, is of a pale brown colour, with numerous divarications; some of these unite for an inch or more, and then separate, and spread at their tips into four or five small branches, with obtuse summits. The growth of this variety differs so much from the general appearance of *Spongia oculata*, that, were it not for the stalk, similarity of texture, and the marginal cells on the branches, it might have been considered a distinct species. The stem is destitute of branches for three inches; the branches are six inches long. This, and the common sort, are found on the coast of Devon.

2. *Stuposa*. With round branches of tow-like appearance, covered with pointed hairs.

Plate iii. fig. 1.—Plate iii. fig. 2. var.—Plate iv. var.

Spongia stuposa. *Ellis*, Zooph. p. 186.—Phil. Trans. 55. p. 288. t. 10. c.—*Gmel.* p. 3822.

What is considered as an elegant slender variety of this species, is beautifully white, and has the branches more ascending, and more tomentose. Perhaps it is the older specimens that become palmated at the divarications, like the antlers of a buck. Both these sponges may be likened to the horns of deer in their soft or velvety state, and one is probably the *Spongia cervicornis* of Pallas. If hereafter these should prove to be different

species, the palmated kind might be called *damacornis*. Coast of Devon, rare.

3. *Palmata.* Palmated, with finger-like divisions on the margin, and little prominent pores irregularly disposed.

 Spongia palmata. *Ellis*, Zooph. p. 189. t. 58. f. 6.—*Gmel.* p. 3822.

This, in some of its varieties, somewhat approaches *Spongia oculata*, is of a similar texture, but not so soft when dry, and the pores more numerous, and disposed all over the surface. Coast of Devon, rare.

4. *Coalita.* Much branched in an irregular and distorted manner, rather compressed, and of a brittle corky substance.

 Spongia coalita. *Gmel.* p. 3825.—*Müll.* Zool. Dan. iii. t. 120.

This species is much branched, and composed of finely reticulated fibres, with seldom any larger pores: the stalk is scarcely larger than the branches, and both usually become sub-carinated at the sides, on which part a few porous tubercles are sometimes observed: the branches are frequently hooked, and turn in different directions, but preserve a flattish form. Coast of Devon, rare.

Müller is certainly mistaken in referring this to the *oculata* of Ellis.

5. *Hispida.* With long, slender, round, dichotomous branches, covered with stiff hairs.

Plate v.

This slender branched sponge appears as if it sometimes grew horizontally on each side from the point of adhesion, which is very slight; in this case, both ends become branched. Others rise perpendicular from the base, which is attached to old shells; in some instances several stalks originate from the same spreading base, but are rarely connected: the branches are nearly round, except where they divaricate. Three, and sometimes four subdivisions take place in the larger specimens; the points of the subdivisions are subacute. Length, a foot or more.

When recent, contains a great deal of gelatinous flesh, and is of a yellowish-brown colour, becoming darker as it dries. The only specimens that have occurred, were taken off the coast of Devon by the trawl; rare.

The description given of *S. tupha*, would tolerably well accord with this, had not that species been stated to be soft, whereas this is hard, and not composed of so fine a texture as S. oculata, and is thickly muricated with hairs.

6. *Dichotoma*. Branched, erect, subcylindric, tomentose, and covered with small pores.

Spongia dichotoma. *Ellis*, Zooph. p. 187. 6.—Phil. Trans. 55. p. 289. t. 11. f. 1. (*Ellis*.) Lin. Syst. p. 1299.—*Berken*. p. 213.—*Gmel*. p. 3822.

Plate vi. fig. 1.

Brown, with long erect dichotomous straight branches, smaller at their summit: at the divarication of the branches it spreads a little, becoming compressed, but never so much as *S. oculata*; from which it also differs in the superior length and straightness of the branches; the texture is also more firm and less woolly. The *dichotoma*, like the *oculata*, originates from a compact ligneous stalk, an inch or two in length, but the branches are truly dichotomous, and they never terminate in more than a fork, and most frequently in a single point; whereas the *oculata* is much more complicated in its branches, which are more compressed, and sometimes inosculate, and their tips become digitated in older specimens; in some the ends are palmated, from which issue four or five fingers. In both these species, numerous branches arise together from the top of the main stalk: in the *dichotoma*, the first subdivision or offset from a main branch, commences close to the base, and another divarication takes place at the distance of two or three inches; but many of the main branches have only a lower divarication, and from thence extend nine or ten inches per-

fectly straight, and gradually tapering to a point. A specimen in my cabinet, taken on the coast of Devon, has not less than a dozen main branches, some of which are eleven inches long. A figure of a branch of this, and of the *oculata* *, are given together, in order to shew the difference of their usual growth, as it is probable they have sometimes been confounded.

A comparative description has been considered in some degree essential for the discrimination of these two species, as the *dichotoma* has not, I believe, been considered as British, but was originally described by Mr Ellis as a production of the coast of Norway. The rows of cells which the *oculata* is described to possess on the margin, and which project a little, does not form a character of distinction, being equally applicable to *dichotoma*; but perhaps in this last, the cells are more disposed over the whole surface. Both species are yellowish when fresh.

Berkenhout is the only one who mentions this species as a native of the Cornish and Yorkshire coasts, but on what authority we are not informed.

* Plate vi. fig. 2.

7. *Digitata.* With very slender dichotômous branches, digitated at their summit; the surface granulated.

Plate vii.

This very slender sponge is tough and flexible; neither the stem nor the branches are so large as a medium straw, slightly compressed: the branches are distant, and usually terminate in a cluster like the foot of a bird; these slender terminal divisions, are from three to six in number. It is compact in its texture, and when examined under a microscope, appears granulated on the surface, as if sprinkled with fine sand: the base of the stem is usually ferruginous, the rest of a pale yellow-brown.

Taken in deep water by the trawl off the coast of Devon; rare.

8. *Ramosa.* Palmated and digitated round the top.

Plate viii.

This curious sponge is stiff, and somewhat elastic; the interior part is ligneous, striated longitudinally, and which is always bare at the ends of the ramifications, where it seems to be composed of numerous fibres that frequently split and divide into fascicles: the spongy or exterior part is of a fine texture: colour pale yellow-brown.

This singular species, which appears to be undescribed, I first noticed in Mr Boyer's cabinet of British shells, chiefly found at Weymouth. I have since taken a larger and more perfect specimen on the coast of Devon, measuring nearly five inches in height.

** Digitated.

9. *Conus.* With numerous short flattish divarications issuing from the sides.

Plate x.

The divarications are irregular in size, shape, and situation, but they are usually compressed, short, and broadest at the end; these sometimes originate from an irregular stalk, giving a little resemblance to an expanded fir cone: the texture is rather coarse, and the outside furnished with spiculæ or short bristles. When dry it becomes stiff and rather hard, owing to the large quantity of gelatinous flesh which is obvious amongst the fibres. Colour when dry, of a dark yellowish-brown.

Coast of Devon; rare.

10. *Lobata.* With clustered ovate divarications.

Plate ix.

The texture of this sponge is rather more coarse than that of *oculata;* the lobes vary from ovate to oblong, and originate from an ill-defined stalk in an irregular manner; they are nearly connected, sometimes inosculate, and are furnished with a few prominent pores without order. Colour, yellowish-brown; height two inches.

Devon coast; rare.

11. *Perlevis.* Form indeterminate, texture close, surface covered with obtuse papillæ.

In texture, this sponge is somewhat similar to *tomentosa;* is equally light, but not so soft and crumbly, nor of so pale a colour; when fresh it is yellow, becoming of a light brown when dry: on the surface are numerous obtuse papillæ, the eighth of an inch in length; these are not tubular, but of the same texture as the rest of the sponge; some are clavated, others bifid or trifid, and compressed; sometimes a few moderate sized pores are scattered over the surface, very visible to the naked eye, being as large as if made by a common pin.

A specimen of about two inches long and an inch broad, taken on the coast of Devon, appears to have been attached to a rock its whole length.

12. *Aurea.* Broad, flat, and slightly divided at the top.

Two or three inches broad, and nearly two inches high, of an orange-yellow when fresh, fading to brown when dry. Sometimes its slight divisions are tubular, but this is of rare occurrence. It is not so much divided as *Spongia prolifera* of Ellis, or might be thought a variety; but in this, the base is always broad and compact, and the summit is more ragged than branched; it con-

tains a great deal of animal gluten, which in drying, contracts and connects the small divisions.

Plentiful in the estuary of Kingsbridge, covering the stones at low water.

13. *Rigida.* With obtuse, spreading irregular flattish divarications, arising from the same base; usually a short stalk.

Plate xi. fig. 1, 2.

This sponge is as coarse in texture as *Spongia officinalis*, and when fresh, is of an orange colour, which it partly retains if tolerably freed from the animal gluten: the divarications are irregular in size and shape, but usually originate from one base or stem. When dried, it becomes rigid, but less so when it has been exposed for some time on the sea-shore, or, by repeated irrigation, the animal gluten is decomposed and washed out.

Height, about an inch.

What is conceived to be a small variety, has the divarications more numerous and distinct, spreading from a short pedicle. In this, the reticular fibres are greatly obliterated by the large quantity of gelatine retained, by the contraction of which, the fibres are connected, and the sponge is rendered hard and destitute of flexibility.

Coast of Devon; rare.

*** Tubular.

14. *Coronata.* A single tube, the summit crowned with radiating spines.

Spongia coronata. *Ellis,* Zooph. p. 190. t. 58. f. 8, 9. —*Gmel.* p. 3819.

This curious little sponge, originally discovered by Mr Ellis in the harbour of Emsworth, is not uncommon on many parts of the British coast; I have found it in the most southern extremity, and have been favoured with it from Zetland by Mr Fleming. The specimen figured by Ellis, is very diminutive; it is usually larger, and one in my cabinet is above an inch in length, but not near so large in proportion as the magnified figure in the *Zoophytes.* It should be remarked, that the specific character of being "surrounded at top by a crown of spines," is rarely identified; but the spiculæ that cover all other parts, form a lasting character. It is generally of a yellowish colour, sometimes of a shining silvery white; and this we may conceive is its true colour, could all adventitious matter be removed.

Found on fuci and other marine bodies.

15. *Botryoides.* Minute, ovate, tubular, in bunches, covered with triradiated spines.

Spongia botryoides. *Ellis*, Zooph. p. 190. t. 58. f. 1.-4.—*Gmel.* p. 3823.

This species, originally described by Mr Ellis, is the only one I have not been able to identify amongst the sponges that zoophytist has given as British. It is very minute, and composed of branches of little oval figures in the shape of grapes, and each is open at the top, (probably tubular.) " When the surface of this species is highly magnified, it seems," says Mr Ellis, " as if covered with little masses of triple equidistant shining spines." These spines were described and figured by Walker in *Testacea Minuta Rariora*, as a minute species of *Asterias*. My late valuable friend Mr Boys of Sandwich, favoured me with specimens of these triple spines, together with most of Walker's minute shells, and they were admitted by that able naturalist to be the spines of *Spongia botryoides*. I do not recollect that Mr Boys had ever seen a perfect specimen of this sponge, nor is it mentioned in his Catalogue of subjects in Natural History in the neighbourhood of Sandwich; but Mr Walker says his *Asterias triradiata* is found on all the shores of Kent; so that we may conclude the sponge is not uncommon in that quarter.

16. *Papillaris.* Sessile, flat, spreading, with scattered tubulous tubercles.

Spongia papillaris. *Gmel.* p. 3824.—*Pallas*, Zooph. p. 391.—S. compacta, Br. Miscel. 1. t. 42?

This sponge is usually attached to rocks, sometimes intermixed with *Corallina officinalis* and others, spreading three or four inches. In a recent state, it is soft and yellow, the tubercles occasionally tipped with blue: when dry it becomes less soft, and turns to a brown or grey colour. When examined by a lens, the surface appears like gauze: the papillæ are various in size, hollow or tubular, and disposed without order.

Common on the south coast of Devon on the rocks that are rarely left by the receding tide.

It will be perceived, that part of the synonyma prefixed, is given with doubt; but we suspect from the appearance of the *compacta* figured by Mr Sowerby, that it is really a fine variety of this species; the surface appears to be the same, and the difference consists in the tubercles being more lengthened, more numerous, and more connected. This fine variety, (as I suspect,) was probably thrown up from the deep, where all marine subjects of this nature, arrive at much greater perfection than nearer the shore, where the continual agitation of the water causes depauperation.

17. *Tubulosa.* Tubular, branched, tough; the tubes erect, and slightly tapering.

Spongia tubulosa. *Ellis*, Zooph. p. 188. t. 58. f. 7.—Lin. Syst. p. 1297.—*Gmel.* p. 3819.—Spongia fastigiata. *Pallas*, Zooph. p. 392.

The external structure of this sponge is so fine as not to be discerned by the naked eye; smooth, and destitute of any detached fibres; when examined by a lens, it is observed to be finely, though irregularly reticulated with smooth fibres: the tubes are hollow throughout, nearly erect, and most commonly originate from a common base, but frequently so close together, as to become more or less united; sometimes smaller tubes issue from the sides of the larger: at the summit the tubes are as thin as paper.

This sponge is not uncommon in the estuary of Kingsbridge at very low water, adhering to stones, and is occasionally taken by the trawl in the open sea on the coast of Devon. It rarely exceeds three inches in height, and four or five inches wide; one specimen contains ten principal tubes of different lengths: the colour when fresh is yellow, but, by drying, it becomes of a pale brown or dirty white.

Making allowance for climate, this approaches so nearly to the Batavian tubular sponge, that I have ventured to consider it a depauperated variety of the species described by Mr Ellis, rather

than run a risk of unnecessarily multiplying species without evident specific distinction.

18. *Foliacea.* Of a fine texture, greatly compressed, and tubular; the inside finely reticulated.

Spongia compressa. *Fab.* Faun. Groenl. p. 448?—*Gmel.* p. 3825?

Plate xii.

This leaf-like sponge usually grows in clusters, each follicle being of an irregular shape, but generally more or less obovate, furnished with a short pedicle, by which it is affixed; and the apex is contracted, having an opening to the tube: some specimens have one or two perforated tubercles on the lateral margin; others shoot into small lateral leaflets, which are also tubular.

The remarkable character of this sponge, is that of being so thin or compressed, as at first sight to be mistaken for a fine *Flustra*, and yet being hollow. Its colour is dull yellow when alive, and in that state, when adhering to the under part of projecting rocks, has so much the appearance of a young *Flustra foliacea*, that it might readily deceive an experienced eye without close inspection. It rarely exceeds an inch in length, and is of a fine texture. It is frequently mixed with stunted fuci, growing in the most exposed situations, subject to the severest agitation of the waves, and is always observed to be pendent.

The only place I have noticed this sponge, is at Dawlish in Devonshire. This is probably *Spongia compressa* of Fabricius? which is mentioned as a production of the Scotish coast in Professor Jameson's catalogue of Vermes, given in the first volume of the Wernerian Natural History Memoirs.

The Reverend Mr Fleming favoured me with a very fine specimen on a fucus from Zetland, under the denomination of *Spongia compressa.* The interior surface of this tubular sponge, is elegantly reticulated, having the pores larger than on the outside; and, when highly magnified, is found to be formed of aggregate, simple spiculæ.

19. *Penicillus.* With a yellowish gelatinous base, supported by internal spiculæ, and bearing on its surface erect, white, flexible, spongy tubes.

Plate xiii. fig. 7.

This is an interesting species of Spongia, as its internal conformation appears clearly to demonstrate its great affinity to *Alcyonium lyncurium* and *cydonium* of Linnæus; while its exterior part is evidently that of a tubular sponge. It must be confessed that I had long considered those *Alcyonia*, as more properly belonging to this genus; but as the asbestine spiculæ with which their interior part is crowded, and the firm fleshy appear-

ance of the exterior part, differed somewhat from the generality of Spongiæ; and as no radiating pores or polypi could ever be discovered, it was in contemplation to form them, and one or two others, into a distinct genus. The discovery of this new species of Spongia, induces me to recall my assent to the formation of a new genus for those obscure species originally considered by Linnæus as Alcyonia: but by removing them into this genus, we shall follow the course of nature, and accord with the opinion of that great zoophytist Mr Ellis. This high authority has, in a few words, defined the leading characters of the *Alcyonium* and *Spongia*, and pointed out their distinction. Speaking of *Alcyonium* in his introduction to *Spongia*, "These polype suckers," says this naturalist, "are the distinguishing characters of that genus, as much as the pores without the polypes in these elastic fibrous bodies, is the character of sponges." With this strongly marked character, stamped by so able and experienced a zoophytist, we cannot hesitate to remove those of the fibrous kind destitute of polypes from *Alcyonium* to *Spongia*; and if ever Mr Ellis himself had the smallest doubts upon the subject, such would have been removed by the examination of *Spongia penicillus*.

The interior substance of this species, is precisely that of *Lyncurium*, but instead of being orbicular, it spreads horizontally upon marine bodies, and shoots upwards from its surface cylindric

tubes of nearly an inch in length, which have an opening at the apex ; these tubes are distant, and not disposed in regular order, nor of any determinate size ; but on the same specimen may be observed tubes from the eighth of an inch upwards, in all gradations, to the length before mentioned. In drying, the tubes become compressed and a little arcuated, and all incline the same way ; they are flexible, tough, and the texture extremely fine. The spiculæ that support the fleshy part, appear to be the base or continuation of the tubes ; perhaps these are ligaments, and may contribute to give some small action to the tubes, by inclining them to either side, or by expansion and contraction. When first separated from the rocks, the asbestine-like spiculæ are not so obvious as when the flesh is contracted by drying. In its general appearance, this sponge bears some resemblance to Lichen filiformis.

The only specimen was taken by dredging, and is an inch and a half in length.

20. *Lævigata*. Soft, compressible, and elastic ; texture extremely fine and reticulated.

Plate xvi. fig. 4.

This is the most delicate of all the soft British sponges ; when compared with either *oculata* or *dichotoma*, their texture is extremely coarse ; by the naked eye, the surface appears nearly smooth, or finely frosted ; when examined with the double

lens of a megalascope, the surface is found to be minutely and elegantly reticulated, and of a cottony softness, but the fibres are infinitely finer than common cotton. Perhaps the texture in fineness would be more aptly compared to the interior spongy part of some species of puff-ball (Lycoperdon.)

The only small piece of this sponge that has come under observation, is tubular throughout; whether this is its natural habit, or the consequence of being a parasitical species that surrounds the stalks of fuci, or other marine plants, has not been discovered; but it is observable, that the central fibres radiate to the circumference; the summit, however, is rounded and perfect, like the finish of an independent species.

Imperfect as the specimen is from which this description is taken, it is distinct from any I am acquainted with, and therefore cannot be omitted. Till its habit is better known, it has been thought proper to place it amongst the tubular sponges.

21. *Ananas.* Ovate, rugous, tubular, the summit crowned with spines surrounding the aperture.

Plate xvi. fig. 1, 2.

This elegant minute sponge, is nearly allied to *coronota*, but is very different in shape and texture; the surface is not covered with spiculæ as in that species, but is apparently vesicular or scaly, and

when magnified, somewhat resembles an extremely fine *Millepora*, except that no openings or pores are visible, nor is it of the same consistence.

The size is expressed in the figure referred to, as also its appearance when magnified.

Devon coast; rare.

Var.? With this, a figure is given of a white tomentose tubular sponge, which is suspected to be the same species in a more perfect state; should it hereafter prove so, the leading characters may require revising. It is affixed to *Cellaria scruposa*, as represented at fig. 3., highly magnified. The shape is sufficient to separate it from *Spongia coronata*, which is invariably subcylindrical.

22. *Complicata*. Tubular, with numerous branches, most complicately interwoven, and frequently inosculating.

Plate ix. fig. 2, 3.

This species is minute, of a very fine texture, and, when dry, is observed to be formed of shining white spiculæ. It is tubular throughout, and the branches are subcylindric, with an opening at the apex, and are frequently bifid, and sometimes trifid: the principal stems originating from distinct bases, throw out lateral branches that anastomose with each other, and then a most complicated communication is obtained throughout a large cluster. When bruised and reduced to fine powder, and the particles highly magnified, many tri-

radiated spines are observable. This circumstance might favour an opinion, that the present subject is only a variety of *Spongia botryoides*. Mr Ellis, who first discovered that species, remarks, that when that sponge is examined under a microscope, the whole surface is observed to be covered with triradiated spiculæ. I could not discover any such superficial spines in *Spongia complicata*; and those triradiated spines which were observed, are not a quarter so large as those belonging to *botryoides*. It must be confessed, that I have never been able to procure *botryoides*, although I am in possession of its triradiated spiculæ, originally sent to me by my late worthy friend Mr Boys, for the minute *Asterias* figured by Walker. If, however, an opinion may be formed from the representation of *botryoides* in Ellis's Zoophytes, there appears to be a very considerable distinction between the two species: that is a cluster of little oval figures occasionally branched, but all its parts retaining an ovate form, and nothing either in description or figure, represents the complicated cylindrical, and frequently inosculating tubes which characterise *complicata*.

This elegant little sponge was found in Zetland by Mr Fleming, adhering to fuci, to whom I am under obligations for a clustered specimen, containing innumerable principal stalks, all more or less uniting in the manner the two here selected are represented.

**** Compact.

23. *Tomentosa.* Irregular, soft, brittle, and full of pores interwoven with minute spines.

Spongia tomentosa. Lin. Syst. p. 1299.—*Gmel.* p. 3821.

Spongia urens. *Ellis,* Zooph. p. 187.

Sponge like crumb of bread. *Ellis,* Coral. p. 80. t. 16. f. d. d. 1. D. 1.—Phil. Trans. 55. p. 288. t. 10. f. A.

Spongia panicea. *Pallas,* Zooph. p. 308.—*Gmel.* p. 3823.—*Turt.* 4. p. 660.

This species of sponge is so amply described by Mr Ellis, that little needs to be said of it; but it may be proper to remark, that the minute spines of which it is formed, and which are said to sting and blister the skin like cow-itch, is not readily discovered except in the larger pores; nor do they always affect the hand by which the sponge is rubbed, for it is only in a very dry state that such an effect is obvious; hence, as Mr Ellis remarks, the property of stinging, is much increased by drying in an oven.

It is suspected that this sponge has been commonly confounded with *Spongia suberia,* though in fact not the least like when compared, either in colour, (when dry,) or in texture; a definitive comparison will be found in the description of *suberia.*

Tomentosa is sometimes thrown ashore on the coast of Devon, and is occasionally found adhering to the roots of the larger fuci. When recent, it is of an orange colour, and soft; when exposed for some time, it becomes white, extremely light and brittle; and when broken, is porous, " in appearance," says Mr Ellis, " like the crumb or soft part of bread."

It will be observed, that *panicea* has been given in a modern work as a British species, distinct from *tomentosa*, perhaps copied from Turton's Gmelin. The reference, however, of Pallas, to the species in Ellis, is the best guide. It may be proper to remark, that the outside of this sponge is very different in appearance from the inside; it is smooth, and when examined by a lens, some parts are found to be finely reticulated like gauze. It is only in the fractured parts that the bread-like appearance is observed.

24. *Suberia.* Crustaceous, compact, tough, without visible pores externally.

This sponge is of a corky nature, resembling the close texture of the stalk of some species of Boleta. It has rarely any other pores than what are formed by the fibres, which are so extremely fine, as not to be visible to the naked eye, even when broken; and with the assistance of a pocket lens, they are not definable on the surface. Its colour is orange-yellow when fresh, becoming

brown when dry: its shape is indefinite, but it has the singular property of being attached only (as far as I have been able to ascertain) to old univalve shells, which it entirely invests. It is also remarkable, that few instances occur, where the Hermit-crab has not formed a lodgement in the nucleus shell, and there appears to be a great struggle between the two parasitical intruders, as the sponge is continually endeavouring to fill up the aperture of the shell, while the crab, by its occasional motion in search of prey, frustrates that natural propensity of the sponge. Notwithstanding the efforts of so active and restless an intruder, the gradual and insensible increase of the sponge gains upon the premises of the crab; it pushes in on all sides, and completely lines the interior surface of the shell, so that the crab soon finds its habitation too small, and is compelled to search for a more capacious house.

The species of shell may frequently be traced, which constitute the nucleus of this sponge. *Buccinium reticulatum* and *undatum*, *Turbo terebra* and *littoreus*, are frequently covered by this sponge, except more or less opening to the aperture of the shell.

It is a curious circumstance, that no instance has occurred where this sponge has been attached to a living shell, or such as were inhabited by its proper animal. Either the increase of the sponge must be very rapid, or its efforts to inclose the aperture of a shell, must be most successfully per-

formed between the period of its being quitted by one inhabitant, and the possession of another; for the hermit-crab is continually changing its abode, in order to accommodate its cell to its growth.

In every instance where a crab has been found to inhabit such a shell, the sponge has invariably spread within the aperture, and frequently a considerable extension of the lip to the shell, is produced by the sponge.

This species of sponge is found on several parts of our coast, which makes me suspect that it has been confounded with *tomentosa*, as it does not appear to have been described. It is not uncommon in the estuary of Kingsbridge, and is frequently taken by the dredgers.

Spongia suberia differs from *tomentosa* as much in its habits as in its texture: it never appears to attach itself to any fixed body; no part of its surface ever indicates such an attachment; and consequently, we may conclude it is not sessile, but independent. It is ponderous (comparatively speaking) even when dry; it has no visible pores to the naked eye even in fractured parts; and its surface is regularly smooth without any little indentations or inequalities, and is hard to the touch.

The *tomentosa*, on the contrary, is always affixed by its surface, is not very fine in its internal texture, is extremely light, brittle, and soft, and its surface full of small inequalities.

25. *Cristata.* Flat, erect, and tender, resembling a cock's-comb, with rows of small holes that project a little, along the top.

Spongia cristata. *Ellis,* Zooph. p. 186.—*Gmel.* p. 3822.

Cock's-comb sponge. Phil. Trans. 55. p. 288. t. 11. fig. G. *(Ellis.)*

The description of this sponge, given by Mr Ellis, renders it needless to add any thing further, than to remark, that this appears to be the only species of *Spongia* in which Mr Ellis ever discovered actual signs of motive power. " When it was taken out of the sea, and put into a glass-vessel of sea-water," says Mr Ellis, " I perceived it to suck in, and squirt out the water through the rows of holes or little mouths along the tops, giving evident signs of life."

Coast of Sussex.

26. *Infundibuliformis.* Funnel-shaped, flexible, with the surface more or less roughened and irregular.

Spongia infundibuliformis. Lin. Syst. p. 1296.—*Gmel.* p. 3818.—Nat. Miscel. iv. t. 145.—Wern. Mem. i. p. 562, *(Jameson.)*

Spongia crateriformis. *Pallas,* Zooph. p. 386.

For the first time, this sponge has been publicly announced as British by Professor Jameson, who found it on the shores of the Island of Unst, Zetland. I have also been informed that Mr

Neill is in possession of a specimen which he found in Orkney. On such authority, it now becomes enrolled as a British sponge.

It must, however, be recollected, that shape alone in such variable subjects, is not always to be depended on; and I am inclined to suspect, that some other sponges, which occasionally assume a crateriform shape, have been confounded with *infundibuliformis*.

Spongia ventilabrum sometimes increases with a regular margin from a central stalk, which becomes more or less concave; and as this shape so materially differs from that from whence its name is derived, there is reason for suspecting, that such variety may, for want of comparison, have been confounded with the true *infundibuliformis*. This crateriform *ventilabrum*, Professor Jameson very judiciously remarks, is distinguished by its reticular woody veins, which are wanting in the other, and by the nature of the spongy substance which covers and connects these veins, which in ventilabrum can be rubbed between the fingers when dry; whereas the Linnæan *S. infundibuliformis* is of a flexible elastic nature when dry, and its general consistence approaches to that of the common officinal sponge.

There is, however, another species which approaches nearer to *infundibuliformis*, being equally destitute of woody veins. This accompanied a crateriform *ventilabrum* from a scientific friend in Zetland, who, at first sight, without close ex-

amination, had considered it as the young of that species. The smaller sponge alluded to, is, however, perfectly distinct from either *infundibuliformis*, or *ventrilabrum*, and which will be found described under the title of *scypha.*

Gmelin has referred to *Spongia foliascens*, as well as to *crateriformis* of Pallas, for this sponge; but he is probably mistaken.

27. *Ventilabrum.* Fan-shaped, with reticulated woody fibres, covered with large spongy pores.

Spongia ventilabra. Lin. Syst. p. 1296.—*Gmel.* p. 3817.—*Ellis*, Zooph. p. 188.—Pontopp. Norw. i. p. 251. t. 13. f. 8.—Wern. Mem. i. p. 561. *(Jameson.)*

Sea-fan sponge. Phil. Trans. 55. p. 289. t. 11. H. *(Ellis.)*

This large species of sponge, has been long described as a production of the Norwegian sea; it was therefore very likely to make its appearance on the northern coast of Great Britain, especially in the north of Scotland.

It was reasonable to suppose, that this, and many other natural productions of the coast of Norway, would be found in Zetland, which more particularly approximates that part of the northern continent. This suspicion has been verified, not only by specimens received from those islands through the kind assistance of my scientific friend the Reverend Mr Fleming, but by its having been

lately recorded as a Zetlandic species in the Memoirs of the Wernerian Society. Professor Jameson picked up several specimens of a sponge in the islands of Unst and Fulah, which appears to be the same as those I received from the same quarter. This naturalist, has, it is true, placed a note of interrogation after his reference to the *ventilabrum* of Linnæus. " It has," says Professor Jameson, " the reticular woody veins, the same kind of spongy covering, and the same general fan-like shape as the species *ventilabrum*." The same naturalist remarks, that it is said that certain varieties of this species are funnel-shaped. " It would seem, however," says this enlightened naturalist, " that these supposed varieties belong to a distinct species." May not *Spongia scypha*, hereafter described, be one of the supposed varieties of this species?

It may be proper to remark, that with both the common fan-shaped and crateriform specimens of *ventilabrum* before me, I am confident these actually belong to the same species, although so different in shape. Upon the receipt of these sponges from Mr Fleming, I remarked to him his mistake in considering a small infundibuliform sponge, which accompanied them, to be a young funnel-shaped *ventilabrum*, as its texture is very different, besides being destitute of the ligneous reticulations which form the support of the spongy fibres in that species.

The specimen before me, of a sub-infundibuli-

form *ventilabrum*, consists of three large lobes, and these more or less divided into irregular smaller ones at the margin, spreading equally from the stalk; the greatest breadth being eight inches and a half, the smallest above seven; the height including the stalk, five inches; the depth of the cavity, three inches.

Another specimen is fan-shaped, but irregularly lobed, having a detached lobe, or a young sponge of about four inches in length, issuing from the top of the stem; and another appears to have been broken off from the opposite side. The height of this specimen is ten inches. Both these sponges are of the same texture, formed by ligneous branches or ramifications anastomosing in a reticulated manner, and covered with the same kind of spongy fibres. They are equally thin, not exceeding a quarter of an inch in the thickest part, and much less near the margin; the whole becoming pervious to light, so that objects may be distinctly seen through the pores of the sponge, when held pretty close to the eye.

28. *Scypha*. Rigid, but not woody, originating from a corky base, and spreading into a cup, slightly cut and indented at the margin: pores fine.

Spongia foliascens. ***Pall.*** **Zooph. p. 395?**

Plate xv. fig. 1.

The shape of this sponge, is that of an inverted

cone, with a very short stalk, which is of a corky nature internally, but superficially porous like the other parts; the hollow spreads like the bowl of a wine-glass, becoming smaller at the bottom: on the surface, there are some trifling inequalities or depressions, and the margin is slightly and irregularly lobed: in the texture it may be placed amongst the finer sponges, the pores being small, and appearing fibrous when examined with a lens.

The height is about two inches and a half; depth of the bowl nearly two inches; diameter of the margin, the same; that of the base, half an inch; colour, pale-brown.

It may be proper here to remark, that this species is much thicker in all its parts than *ventilabrum*, has the pores of the sponge considerably finer, and so closely interwoven, as to be impervious to light: it is firm, and does not readily yield to moderate pressure, and has no flexibility. With such opposite characters, it can never be confounded with either the crateriform variety of *ventilabrum*, or with *infundibuliformis*; whether this is constant to a cyathiform shape, must be left for the determination of our northern zoophytists.

The species here described, was, as I have before mentioned, taken by Mr Fleming in Zetland, who kindly favoured me with it amongst other productions of those islands. To that gentleman, therefore, we may look with reasonable expecta-

tion for information concerning this, and some other species in this intricate class, which are found in that most northern part of Great Britain.

Is not this the younger specimen of *foliascens* described by Pallas?

29. *Pulchella.* Composed of fine reticulations, smooth and soft in appearance, and generally compressed and broad.

Spongia pulchella. Br. Miscel. p. 87. t. 43.—Wern. Mem. i. p. 562. *(Jameson.)*

This species is described to be extremely irregular in shape, sometimes approaching to fan-shaped, sometimes rather palmated or digitated. Its fibres are delicately reticulated: like the common officinal sponge in colour, it varies from palish-brown to yellowish or reddish brown; from which it is, however, readily distinguished by its less coarse appearance; and its texture may be somewhat more rigid.

Mr Sowerby, who first publicly noticed this sponge, received specimens from Ireland, and from the north of Wales.

Professor Jameson remarks, that Dr Walker first noticed it on the shores of several of the Western Isles.

30. *Cancellata* *. With reticulated fibres, the inosculations tuberous, and furnished with a pore.

Spongia cancellata. Br. Miscel. p. 131. t. 60.

The ingenious author of the work referred to, has presented us with a new, and from the figure we may conclude, a very small species of sponge. This cancellated sponge appears to have large interstices between the fibres, and we are told the fibres themselves when magnified, are also cancellated, and have a horny appearance.

The colour is yellowish; and we are informed that it was found at Brighton in Sussex.

Mr Sowerby remarks, that the kneed appearance, and the swelling at the bend of the knee, with the inverted conical aperture, give an assurance that Spongia is more or less the habitation or nidus of some animal. This is not exactly consonant with my ideas on the subject. If the sponge here described could be discovered to be the habitation of polypi or other aggregate or independent vermes, acting by common consent, it would constitute an animal substance differing from that of spongia. The pore, and the tumidity of the fibres at the points of union, are singular specific characters; the former I have

* Not *Spongia cancellata* of Gmelin.

not observed in any species that have come under microscopic examination, and none so completely œdematous as represented by the figure referred to.

31. *Limbata.* With the fibres formed into larger and smaller circular pores, resembling lace.

Plate xv. fig. 2, 3.

This sponge is firm and elastic; but the pores formed by the anastomosing fibres, are considerably large: it is whitish when divided, and its lace-like appearance when examined by a lens, renders it a beautiful object: the pores or interstices of the fibres are circular, and it frequently happens, that numerous small pores surround a large one; and in most cases the intervals between the larger, are filled up with smaller pores. The fibres are smooth, and destitute of any fimbriæ or detached unconnected parts.

A small specimen, or fragment only, of this elegant sponge, has once occurred surrounding the smaller stalk of some fucus.

Coast of Devon.

32. *Fruticosa.* Tough, elastic, reticulated, the fibres smooth, slightly connected, and distant.

Spongia lichenoides. *Pallas*, Zooph. p. 378?—*Gmel.* p. 3824.

Plate xiv. fig. 3, 4.

This sponge is extremely light and elegant in appearance, like a shrubby lichen: the fibres are very distant, so that a large piece is, in a dry state, pervious to light: it is rather more compact about the base, from whence it usually spreads into large lobes, which frequently have the vertical fibres somewhat radiating from the base, and the decussations more distant. From the sinuous appearance of the larger specimens, it seems to attach itself to the stalks of large fuci; but as it inhabits the deep amongst rocks, it has never fallen to my lot to procure a living specimen. After violent storms, it is frequently ejected, and then is sometimes at first brownish, but soon becomes white by the conjoined action of the sun, the air, and the water. In this state, when all the animal gluten has been completely removed, the fibres under a lens exhibit a silky or asbestine appearance, and seem to acquire a superior tenacity. The larger pieces of six or seven inches in length, and half as much in breadth, are rude, shapeless, and usually have the terminating fibres worn away. It is in such older specimens that *Balanus spongia*, described and figured in *Testacea Britannica*, makes

a lodgement. The fleshy, or gelatinous substance which fills the interstices of the ligamentous fibres of every sponge, has not, that I am aware of, been detected in this species; from whence we reasonably infer, that it comes from the deep, and that, though it may by some accident be removed from its natural fixed abode, it is not ejected till it has lost much of its specific gravity by the decomposition of the fleshy parts, which, from analogy, we may conclude, are readily perishable. The inosculations of the fibres, are extremely variable, and form very irregular reticulations. Besides these uniting fibres, it is thickly interspersed with more minute unconnected branches, arising from the sides and angles of the anastomosing fibres.

This sponge, which is by no means uncommon on the western coasts of England, especially those of Dorset and Devon, I do not find described as a native; but as it agrees in many particulars with *lichenoides* of Pallas, may it not be that species? It must, however, be remarked, that *fruticosa* has a strong animal odour in combustion, whereas we are told, *lichenoides* has a vegetable odour.

33. *Fragilis.* Fragile, friable, coarsely reticulated; the fibres rugose as if covered with minute sand.

Plate xiv. fig. 1, 2.

The above specific characters are sufficient to distinguish it from *fruticosa*, with which it might easily be confounded by a cursory observer. The first obvious distinction to the naked eye, is a slightly frosted appearance, and the colour more usually brown: upon handling, the fibres readily break, and a slight friction between the finger and thumb, reduces it to powder like sand; but this arenaceous appearance is found, by the assistance of the microscope, to be a tenacious vesicular substance, possessing in some points of view, (when examined under the condensed rays of the sun, or a lamp,) a micaceous lustre.

A single specimen of this sponge in my cabinet, was originally collected for *fruticosa*, and the distinction was not immediately discovered.

Coast of Devon.

34. *Parasitica.* Texture coarse; form indefinite, determined by the body on which it creeps.

Frequent on Sertulariæ, sometimes following the course of the branches individually, which it envelopes; at other times spreading laterally, and uniting the branches together, becoming an unformed mass: the texture is rather coarse, and the

fibres fimbriated. Sometimes in larger masses at the base of Sertularia antennina, and other vesicular corallines.

Not uncommon.

35. *Fava.* Irregular, extremely porous, rather hard and brittle, appearing like a piece of old worm-eaten cork.

This sponge, though harsh to the feel, yields to the pressure of the finger-nail without elasticity: when recent, is orange-yellow, and full of gelatinous flesh, but when exposed for a time on the shore, and the fleshy parts decayed and washed out, the pores are observed to be roundish. When examined by a lens, has a slight resemblance to a honey-comb; the pores, however, are not regular in size. If taken fresh, and artificially dried, the pores are greatly obscured by the contracted gluten, and the colour becomes of a dark brown. If it has undergone a natural decomposition of the more perishable parts on the sea-shore, by the conjoined action of the water and the air, the pores are cleared, and it retains a light yellowish colour. A specimen in this state before me, is flat and broad; round the edges, (which appear to have been broken,) there are many large round openings, intersecting the smaller pores, and communicating with those on the flat surfaces. This piece is three inches long, two broad, and about half an inch thick.

Coast of Devon; not common.

36. *Plumosa.* Irregular, rather soft and tough, when deprived of its gelatinous flesh, somewhat resembling compressed tow.

The texture of this sponge is not very fine, but loose, and pervious to light, not very unlike *officinalis*, but of a paler colour, and not so compressible and elastic: it is composed of small fimbriated or feather-like fibres that intersect each other, interspersed with larger pores. It has not been ascertained to what size this species grows, or to what it is naturally attached. One or two specimens only have occurred: these are of a yellowish-white colour, about three inches high, and more than two inches broad.

Coast of Devon; rare.

37. *Coriacea.* Shape indefinite, wrinkled and cavernous, not unlike a piece of burnt leather.

The fibres that constitute this sponge, are composed of very fine spiculæ, and are intersected with numerous large pores and cavities, giving the appearance of singed leather, or a piece of dark-coloured worm-eaten wood in a very decayed state. One side is rather smooth, with circular depressions or cavities. The only specimen that has occurred, is much depressed, four inches in length, and about two in breadth.

Coast of Devon.

***** ORBICULAR.

38. *Verrucosa.* Globose, and externally verrucose; internally fasciculate, with rigid asbestine radiating fibres.

Alcyonium lyncurium. Lin. Syst. p. 1295?—*Gmel.* p. 3812?

Alcyonium aurantium. *Pallas,* Zooph. p. 357?

Plate xiii fig. 4, 5.

It has long been a matter of doubt, whether some of the present *Alcyonia,* without evident stellate pores, and composed internally of asbestine spiculæ, do not in reality belong to the genus *Spongia.* Mr Ellis was favourable to this opinion. Not having the means at present of comparing all the figures given by different authors for the several orbicular species of supposed *Alcyonium,* it is with considerable doubt that I have referred to *lyncurium* for *Spongia verrucosa,* hereafter described. Müller has given an orbicular species which he calls *Alcyonium cranium, Zool. Dan.* iii. tab. 85., and has referred to the Linnean *lyncurium.* If this is truly the Linnean species, it is not in the least like what is here described; though it is probably a *Spongia.* Müller has also figured what he considers the Linnean *Alcyonium cydonium, Zool. Dan.* iii. tab. 81.; but this is clearly an *Alcyonium,* bearing innumerable polypi;

and we cannot therefore think it is the same as the *Alcyonium cotoneum* of Pallas, which may be the Linnean *cydonium*, and is probably a *Spongia*.

With such insurmountable difficulty as that of affixing the synonyma to this, and many other subjects in this very intricate class of beings, I must solicit the indulgence of the scientific, and leave them to decide if the species here described, and accompanied with a figure, is, or is not, the *Alcyonium lyncurium* of Linnæus.

Spongia verrucosa is globous, of a yellowish colour, extremely verrucose, and fleshy, which becomes very hard by drying, and is of considerable gravity even in that state: the warts on the surface, are approximating, irregular in shape, and destitute of any pore: the internal part or nucleus, is composed of fasciculate fibres, connected by the animal gluten; these fill the whole internal cavity, and radiate to the centre, appearing like threads of asbestus.

The specimen from which the figure is taken, was found on the coast of Devon, and is about an inch and a quarter in its greatest diameter, for it is not quite a regular orb, but very slightly depressed; at the base, the coat is a little broken by separation from the body to which it was affixed, displaying the internal asbestine spiculæ.

39. *Pilosa.* Globous, fleshy, covered with short thick-set hair: internally, fasciculate with rigid asbestine fibres, radiating from the centre.

Plate xiii. fig. 1, 2.

This is another of the solid orbicular sponges which may possibly have been confounded with *Alcyonium lyncurium*, or *cydonium*; indeed I cannot be certain it is not the latter divested of its tomentose covering, when, by the assistance of a lens, a truly spongy surface is observable. In this imperfect state, it might conform to *Subrotundum spongiosum flavum læve;* but I dare not venture on synonyma. The discordances of zoophytists are so great, and the synonymes so numerous, that it is utterly impossible to make out the species; and we are constrained to form new species, where characters do not accord. This is nearly allied to the preceding *Spongia verrucosa*, which in some degree may be likened to *Alcyonium lyncurium*, because it is verrucose. The present subject, *Spongia pilosa*, was taken by Mr Fleming in Zetland, who favoured me with a specimen. I shall therefore only give a description of it, and if any thing should be omitted in its usual characters, it is to be hoped, that, we shall receive from that naturalist any additional information.

The specimen of Spongia pilosa before me, has the pilosity removed from one side, shewing the

spongy reticulated covering, but which, in the other part, is perfectly concealed by a thick-set and very fine cinereous hair. Like *Spongia verrucosa*, it is rendered hard by the drying of a large portion of animal gluten that forms the exterior part or coat, and which consequently gives rigidity to the spongy surface. The hairs which cover the surface when perfect, are in fact continuations of those long asbestine-like spiculæ that fill the whole internal cavity: when the coating or fleshy part that surrounds these spiculæ is cut, and the sponge is pulled asunder, the fibres are drawn out their full length, and as the fleshy part contracts in drying, they derive an inclination to twist, and appear so numerous and prominent, as if they could not have been contained in the sphere. But to explain the subject more fully, a figure accompanies this, of the natural size, as well as the appearance of the surface when magnified.

Diameter about three quarters of an inch.

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VII. *Mineralogical Description of Tinto.*

By Dr Macknight.

(Read 11th April 1812.)

Tinto, the subject of the following paper, is a mountain of Lanarkshire, which rises to the height of about 1700 feet above the flat, to the east of its base, and 2300 from the level of the sea *. Standing distinct from the mountain-ranges which appear on the south and east, and from which it is isolated by the intervening course of the Clyde, it forms a conspicuous and magnificent object, as viewed from the adjacent lower country, on the north and west.

The name of *Tinto*, which signifies, it is said, "the Hill of Fire," seems to imply, that in ruder

* This mode of estimating the height of Tinto, may probably reconcile the very different statements of it, which have been given. Jameson's Geognosy, p. 315.

ages, its lofty summit had been regarded as an object of veneration by the surrounding inhabitants, perhaps the scene of some particular superstition; or it may have been employed in time of war, as a signal or alarm-post for the neighbouring country. However this may be, the cairn or heap of loose stones, which forms the highest point of the mountain, and by some is considered as having originally been a Druidical temple, has probably been the gradual accumulation of many ages.

As pasture-ground, the base and ascent of this mountain on every side, must be extremely valuable to the proprietors. But that circumstance lessens its interest, as a subject for either the painter or the mineralogist. The general form of its outline in a distant view, is beautiful and striking; but its minute features, compared with those of alpine regions, are smooth and uninteresting. Tinto presents no rugged peaks, serrated ridges, or bold precipitous fronts of rock; it has few traits of alpine rudeness, and is rather a grand than a picturesque object. Hence its facilities of mineralogical examination, are so imperfect, that on being conducted by the usual path to the summit, for the first time, in the whole of an ascent, extending nearly to three miles, I was unable to discover a single trace of rock *in situ*; so completely is the surface enveloped in soil and debris. Subsequent investigation, however, proved more fortunate; and although by no means

entirely satisfactory, from the smallness and infrequency of the rocky masses which remain uncovered, was such, I trust, as has enabled me to ascertain the formation of the mountain, and to convey a tolerably accurate conception of its structure.

From these remarks, it may in general be presumed, that Tinto is of *secondary* formation. The eastern extremity of its base, forms the lowest boundary of the mountain-valley along which the Clyde flows. From this level, the base springs with considerable steepness, to the height of about 400 feet, where we arrive at the first stage or rounded back: and after ascending another height of perhaps 500 feet, a second platform, with an inclination towards the west, brings us to the acclivity, from which the elevation proceeds to the summit without interruption; exhibiting the elegant conical or rather ellipsoidal figure of this noted mountain. From the foot of the western acclivity, Tinto stretches into a long and apparently unbroken ridge, which penetrates the country for several miles to the south-west.

The sketch which accompanies this paper, though very imperfect, will enable the Society to follow the description I am now to give.

Tinto, then, in the language of Werner, may be described as a flœtz mountain superincumbent, I conjecture, on grey-wacke. For, of this rock, which is known to extend like a zone or belt across the country, from St Abb's Head on the

north-east, to the extremity of Scotland on the south-west, the great mass of the Tweddale hills in the vicinity of Tinto, seems to be composed.

The substance which lies immediately over it, in the body of the mountain we are describing, is a conglomerate, having a basis of clay, with a dark greyish colour, and somewhat resembling an intimately mixed greenstone. The fragments it contains, are from the size of a grain, to that of large balls; and consist of rounded or water-worn masses of transition rocks, such as grey-wacke, grey-wacke-slate, iron-clay, and common flinty-slate, with veins of quartz. There are also fragments or nodules of quartz, mica, felspar, splintery hornstone, and felspar passing into conchoidal hornstone.

This conglomerate, I conceive, forms the base of Tinto; as it is found, either *in situ*, or in the form of debris, at various places around the lower part of the hill, particularly on the south side, a little above the old ruin opposite to Lamington. Where the rock becomes finer grained, as on the north side, it exhibits scales of mica, and both in appearance and in composition, bears a strong resemblance in some places to grey-wacke, and in others, to those portions of the old red sandstone which are conjectured to alternate with the newer members of the transition series. It is therefore probable, that, were the base of the mountain laid bare, we should discover indications of what is

here supposed. The colour of the rock to which I allude, is most generally greenish-grey.

Over the conglomerate, which crops out at different heights along the base on the south side, masses of claystone, greenstone, and greenstone passing into clinkstone and porphyry-slate, successively appear, till we arrive at the summit of the mountain, which is found to consist of compact felspar, and felspar-porphyry, with crystals of quartz, mica, felspar, and hornblende. The felspar rocks also contain thin layers or beds of reddish-coloured quartz.

That these substances, composing the great body of Tinto, are disposed in beds, is sufficiently probable; but, it would be more than is warranted by my observation, were I directly to assert the fact, having been unable to do more than ascertain their separate existence and relative position in the order mentioned. So far as I could judge, if the felspar is in beds, they are almost vertical, and run nearly in the direction of north-east, and south-west.

The nature and characters of the felspar, which in general may be described as slaty-compact, are distinctly shewn by the cropping to be seen about half a mile below the summit, towards the south-west, where the surface over a great extent exhibits this variety of the rock, both *in situ* and in detached masses of all sizes, decomposing in plates or layers of various thickness, from a quarter of an inch to half a foot.

At the foot of the mountain in this direction, a quarry has been opened, in which I found it impossible to procure a fresh specimen. The rock seems to be a fine-grained sandstone, not unlike grey-wacke-slate. There is also a portion of compact greenstone.

Returning eastward, on the south side, we come to a stream nearly opposite to Wiston Hill, in the course of which, about half way down the declivity of Tinto, compact greenstone, and a rock intermediate betwixt greenstone and porphyry-slate or clinkstone, appeared *in situ*, a little above the conglomerate, over which they lie. I found here a vein of felspar, evidently filled from the superincumbent formation.

The next object of any importance, which presents itself in the same direction, is the Pap-Cragg. Here the substances just mentioned, ascend to a height not inferior to that of the slaty compact felspar already described on the south-west face of the acclivity; but I could not discover the line of their junction with the felspar rock. The Pap-Cragg is an abrupt conspicuous front of some size and extent, containing greenstone, and greenstone with specks of earthy or mealy zeolite, which give it the appearance of an exact porphyry-slate. Among the debris below the Cragg, fragments of clinkstone occur abundantly.

A little farther towards the east, and at an elevation somewhat lower, the conglomerate appears at its greatest height; and from this point, seems

to stretch beneath a gradually descending line to the eastern extremity of the base. At this extremity, and at a small height above the level ground, we observe the commencement of the claystone and felspar formation, which lies over the conglomerate and greenstone rocks, and by means of the reddish-coloured debris, above the line now mentioned, may be traced westward, along the brow and rounded back, to the summit of the mountain, forming the whole of its upper part. The claystone passes into felspar, and occasionally presents dendritic delineations and veins of heavy-spar. I am inclined to think, that betwixt the conglomerate and the claystone, there is all along interposed a mass or bed of the greenstone substance which appears in the Pap-Cragg, and which, here, might be supposed as in fact nothing else than the base of the conglomerate unmixed with the coarser fragments that occur towards the lower part of the base: but I had no opportunity of verifying the conjecture.

On the declivity of Tinto, towards the north and north-west, similar substances occur: but the felspar formation descends considerably lower down than under the south side of the summit. The body of the mountain on the north side, is indented by three deep re-entering angles, and presents two vast projecting shoulders, one facing the north, the other inclining to north-west. These shoulders are evidently covered with the porphyry formation which composes the summit, and ex-

tends over the eastern acclivity and ridge of the mountain; but underneath it, the same rocks, claystone, porphyry-slate, and conglomerate, with the addition of the sandstone resembling grey-wacke, occur in the same relative position, as on the opposite side.

In particular beds of the north-west re-entering angle, the claystone assumes a brecciated appearance. Sandstone occurs, which appears to be a mixture of claystone and quartz. The overlying slaty-felspar, contains minute portions of a crystallized matter, like vesuvian or garnet. In other specimens, the felspar inclines to hornstone. The whitish debris of the felspar and claystone, is particularly conspicuous, in the re-entering angle that faces the north under the summit, where it covers the whole of the east side, almost to the bottom of the ascent.

Along the Kirk-Burn, which runs eastward, from the great north-east re-entering angle, the usual phenomena of this mountain are to be observed. The felspar and claystone may be found *in situ*, at a lower elevation than elsewhere, and in the vicinity of the conglomerate and sandstone, which here form considerable heights to the north of the rivulet. Among the debris of this stream, I met with a beautiful specimen of the Petrosilex of the Swedish mineralogists; it is porphyritic compact felspar, approaching to hornstone, with crystals of hornblende, and a fracture compounded of the splintery and conchoidal.

With regard to the environs of Tinto, the rising ground called the Castle Hill, about a mile from the foot of the mountain, on the south-east, consists, as far as I could ascertain, from the minute croppings it affords, of greenstone, which, I presume, trends eastward to a considerable distance, the quarry near the church of Symington having uncovered a bed of that substance. This greenstone is probably newer than the greywacke, which I suppose lies beneath the base of Tinto.

On the Castle Hill, I found a variety of fragments and rolled masses, which serve to illustrate the nature of the rocks in this district: greywacke, common flinty-slate, flinty-slate with veins of quartz, felspar-porphyry with a violet hue, and specks of a greenish matter somewhat resembling the newly designated Pimelite of Karsten; also sandstone with casts, and a very compact brecciated stone, having a basis approaching to greenstone, and including fragments of quartz, iron-clay and jasper.

Amygdaloid, another member of the flœtz class, is the rock which forms the bed of the river, at the new bridge erected over the Clyde, on the road to Biggar. Its base is wacke, and it is surrounded by beds of fine-grained and compact sandstone, coloured with green earth. The vesicles are filled with nodules of calcedony, coated with green earth, and having quartz in the

centre. Other specimens contain quartz passing into flint, and amygdaloidal portions of steatite. Calcspar, too, is an abundant ingredient of this rock. Where it joins the sandstone, there is a mixture of both substances,—a frequent appearance in such cases. Some miles to the westward of Symington, limestone occurs; but I did not examine it, or procure specimens.

On the other hand, the sandstone of which the whole inferior districts of Lanarkshire are composed, and which may be traced for so many miles along the course of the river, I consider as belonging to the same formation with the sandstone-conglomerate at the base of Tinto; and as corresponding to what is called in the Wernerian system, the Old Red Sandstone. It is to the waste of this rock that we owe the splendid scenery of Cora-Lin, and the other celebrated Falls of the Clyde, which have long attracted the notice and admiration of travellers. In its descent to the lower country, it appears to be still accompanied with portions of the same substances which overlie it in the body of Tinto; as porphyry-slate and felspar-porphyry have been found near the Cora-Lin. Below the Fall of Stonebyres, the rock assumes a coarser texture; and, if I am rightly informed, again exhibits a conglomerate, similar to that of Tinto, by including masses of transition-slate, splintery hornstone, quartz, jasper, and flinty-slate.

In concluding the delineation of Tinto and its neighbourhood, I may remark, that the relative disposition of the several rocks composing its mass, corresponds with sufficient exactness to the geognostic description of a flœtz mountain. The conglomerate every where occupies the lowest place, and is covered, in a manner perfectly conformable to the most natural idea of deposition, with greenstone, claystone, and felspar, all evidently of flœtz formation, and assuming a finer and more crystalline texture as we ascend.

This occurrence of claystone and felspar, in a position corresponding to what is found in the Eildon Hills, the Pentlands, the Ochils, Papa Stour, around Dundee, and in other places, appears to favour the hypothesis of a particular overlying flœtz formation, in which these substances are prevailing ingredients, extending over a considerable portion of the lower country of Scotland. I am informed, that the districts adjoining to Hallé in Westphalia, are of a similar structure and description. The conglomerate of the Grampians, seems to have been formed from the debris of older rocks.

It is also worthy of observation, that the characters and relative position of the conglomerate on which Tinto rests, considered in its connection already described, with grey-wacke on the one hand, and the older sandstone on the other, seem to furnish an illustration of a very important fact;

namely, that there are alternations between the oldest members of the Flœtz rocks, and the newest portions of the Transition series,—corresponding to a similar relation, which has been observed between the newest Primitive and the oldest Transition rocks. We thus learn, that the newest members, for example, of the primitive, do not immediately cease, or at once give place entirely to the transition rocks; but that, most frequently, before these are found completely to prevail in the order of succession, alternations, as now mentioned, take place. And the remark may be generalized respecting the junctions of all the successive classes in the system, down to those of the latest periods.

The account I have given of the structure of Tinto, approaches perhaps as near the truth, as the geognostic inspection permitted by the state of its surface, authorises. Future investigation will no doubt, correct or improve it. I cannot hope, that it will be found to contain much that is particularly interesting to the mineralogist. It records no occurrence of rare or precious minerals,—no irregular junctions, dislocations, or extraordinary phenomena of stratification, to raise the astonishment

of the observer, or exercise the philosopher's talent of explanation. But he who exhibits a faithful picture of what he sees in nature undescribed before, contributes something to the progress of knowledge; and, without pretending to assert, that the mineralogists of the German school have yet possessed themselves of all the domains to which they lay claim in the mineral kingdom, we may safely presume, that, at least, they are fairly on the way to accomplish at length a complete system of accurate description, without which, it is vain to expect, that geology will ever ascend beyond the rank of ingenious theory, or become a science.

I have only to add, that if this mountain shall again be surveyed mineralogically, the observer need hardly promise himself, that the geognostic result of his examination of the ground over which he passes, will prove entirely to his satisfaction. At the same time, if he is fortunate in weather, and has a relish for the beauties of nature, he will be gratified in another way, by attending to the prospect seen from Tinto, which spreads before the eye of taste, an uncommon variety of agreeable objects, and a great extent of interesting scenery.

The expanse of country which it embraces, appears unbounded on the west side; but towards the north, it is terminated by the majestic Ben-Lomond, and the lofty ranges of the Highlands,

crowding irregularly into view, in a manner extremely picturesque. In the opposite direction of the south-east, the prominent features of this view, are the bold undulating mountain-lines, the finely grouped masses, and the alternate swells and deep hollows of the Tweddale hills; amongst which, the most remarkable is Culter-Fell, distinguished as the rival of Tinto itself, in size and height. These magnificent objects, presenting themselves on the one hand, form an admirable and striking contrast to the delightful appearance, on the other hand, of the level country that stretches along the banks of the Clyde. What adds to the effect, and can hardly fail to strike the eye at first sight,—the different places where the river displays its shining surface, seem, as if disposed with the happiest skill, for producing the impression of the picturesque.

This noble stream, which shews in its course so many charms of natural scenery, and whose fine sweeps through the mountain-valley, and lower districts of Lanarkshire, are so great an embellishment of the whole prospect, may in truth be said to carry along with it, beauty and fertility from its very source. It is equally pleasing and unexpected, to find at the height of 600 feet above the level of the sea, a tract of land, so rich in soil, so well cultivated, and so extensively clothed with plantations, as the district spreading around the foot of the mountain, from Hyndford-house to

Symington and Culter, and up the river to a considerable distance. The effect of the landskip is completed by the number of villas, and other marks of population and comfort, which every where appear in the vicinity of the Clyde.—There are few elevations in the United Kingdom, where a finer assemblage of the grand, and the beautiful in nature, may be contemplated, than from Tinto.

VIII. *Short Account of the Rocks which occur in the Neighbourhood of Dundee.*

By the Rev. John Fleming, Flisk.

(In a Letter to Professor Jameson.)

(Read 22d February 1812.*)*

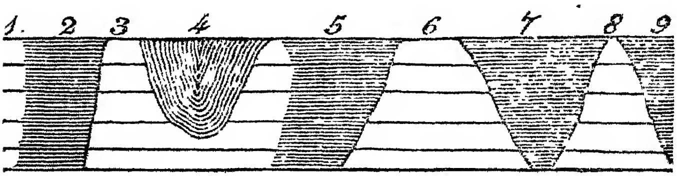
Sir,

In answer to the inquiries which you made some time ago regarding the position of the claystone and porphyritic rocks in the neighbourhood of Dundee, I send you the following remarks, which I made, while walking along the shore of the Tay, from Invergowrie eastward to the town of Dundee.

In the bay at the old church of Invergowrie, the shore is level, and composed of gravel; but, on the east side of the bay, the rocks of sandstone form a steep precipice. This precipice is about thirty feet high, and continues nearly to Dundee,

of the same height, independent of the variety of rocks, forming a steep bank on the north side of the river Tay. In this bank, there are some important sections of the strata displayed, which I propose to describe.

Where the sandstone begins at the east side of the bay, it occurs in thin strata dipping to the north-west, at an angle of about 15°. This sandstone soon disappears, when a mass of porphyry forms the bank. Its western extremity is but indistinctly displayed; its eastern extremity is covered with sandstone. This porphyry has a slaty structure in the great, is composed of a basis of compact felspar, and contains numerous crystals of common felspar, and a little basaltic hornblende. The sandstone soon gives place to the porphyry which rises below it, and forms the precipice for a considerable distance. East from the Boothe, there is a mass of sandstone interposed, as represented at fig. 2.



The porphyry, fig. 1., is disposed in strata about four feet in thickness. It is traversed by a vein containing calc-spar, brown-spar, and sparry-ironstone,—minerals which are nearly related, both in their oryctognostic and geognostic characters. The

line of junction between fig. 1. and 2. is indistinct. The other extremity of this mass of sandstone, rests upon the porphyry, fig. 3. In this last-mentioned porphyry, fig. 3., there is a basin-shaped cavity, fig. 4. which has been filled up with sandstone. The strata of sandstone are parallel with the inclined edges of the cavity. The same bed of porphyry farther eastward seems to rest on the sandstone, fig. 5.; but the appearances are indistinct.

The sandstone, fig. 5., rests upon the mass of porphyry, fig. 6. This last porphyry varies in colour and composition in different portions of the bed. Some portions are of a grey colour, with imperfectly formed crystals of earthy felspar, while other portions are reddish-brown, and contain besides the felspar a considerable number of crystals of hornblende. This porphyry soon gives way to another deposition of sandstone, fig. 7., both extremities of which rest upon porphyry, and exhibit an instance of an *upfilling*.

The last mass of porphyry, fig. 8., is again covered on its eastern side with another mass of sandstone, fig. 9. This sandstone includes a bed of greenstone, specimen 5.

From the place where the last bed of sandstone, fig. 9. commences, to the place called the Crescent, the mineral appearances are but imperfectly disclosed, as may be seen in the figure, which, with the specimens, will convey all the information which I could obtain.

S.

				Sandstone.
Sp. 5.			Sp. 12.	
	Sp. 6.	Sp. 7.		

The specimen No. 5. *, is greenstone; its fragments sound like clinkstone. Specimen 6., is a greenstone abounding in felspar, in a state of decomposition. Specimen 7., is a soft claystone-porphyry. Specimen 12., is a claystone-porphyry, with minute grains of sand.

Opposite the Crescent, the rocks disappear, and the shore becomes level. Here, however, a rock of greenstone appears rising among the rocks of the shore. It abounds with hornblende, and is in some places amygdaloidal. Specimen 8. is from it.

Passing this mass of greenstone, the relations of which I could not ascertain, a bed of claystone, specimen 11., equally imperfectly exposed, makes its appearance on the shore. After passing this claystone, rocks of greenstone now form the shore, and continue without interruption to the town of Dundee. Specimen 10., is from this bed of greenstone. In the neighbourhood of the town, the greenstone seems to pass into clinkstone,—a

* The numbers refer to the specimens presented to the Wernerian Society, and deposited in their collection.

transition, which, I think, I have observed in other places.

From the preceding description, it will appear, that many changes have taken place in the position of these beds of sandstone and claystone since the period of their formation. But, of the cause of these dislocations or slips, we are entirely ignorant. The situation of the strata of sandstone in the basin-shaped cavity of the porphyry, makes us acquainted with a fact in the history of stratification, of the greatest importance. The abettors of the vulcanic hypothesis contend, that all the strata of rocks were originally deposited in a horizontal position. The fact before us, is in opposition to such an opinion. The strata in the bed of porphyry are nearly horizontal, whereas the strata of sandstone are highly inclined, being parallel with the sloping sides of the basin. If we suppose one of the sides of this cavity removed, and the inclined strata on the other side of the cavity left behind, a superficial observer would be ready to conclude, from such partial appearances, that these inclined strata had been moved into their present angular position by an ascending movement of the inferior bed of porphyry. Instances frequently occur to every practical mineralogist, where highly inclined strata thus rest upon the inequalities of the fundamental rock, which, to all appearance, has never been moved. The disciples of the German school embrace the opinion, that "in

strata composed of chemical precipitates, all the variety of inclination depends on the inequality of the bottom ;" and in this they are confirmed, not so much by attending to appearances in small portions of rocks, such as here described, as by an examination of the structure of mountain masses.

These few remarks certainly lead to little that is precise or important in the history of the strata, now described. They indicate, however, the intimate relation which subsists between the sandstone and the claystone. This relation, I had previously ascertained in my examination of the Island of Papa Stour * ; and the observations which I have recently made on the south bank of the Tay, tend still further to confirm and illustrate it. At Fliskwood, directly opposite to the north bank of the river, where the appearances detailed above are exhibited, the sandstone covers the claystone. Here the sandstone rests upon very soft clay-porphyry, which passes into claystone. This claystone at last becomes more compact, assumes the amygdaloidal structure, and then becomes connected with compact felspar.

These appearances seem to indicate the existence of a family of flœtz-rocks, consisting principally of claystone, felspar, and sandstone, the relations of which are but imperfectly understood.

* Wernerian Memoirs, vol. i. p. 162.

Should these remarks appear to you sufficiently interesting, I beg of you to communicate them to the Wernerian Natural History Society, with my best wishes for its prosperity. I am, &c.

IX. *Observations on the Mineralogy of the Neighbourhood of St Andrew's in Fife.*

By the Rev. John Fleming, Flisk.

(Read 5th February 1813.*)*

The county of Fife contains two very distinct formations of rocks, which belong to the Flœtz class. The country to the north of the river Eden, which runs through Fife in a direction of west to east, contains strata which are connected with the Old Red Sandstone, and are geographically related to the beds of sandstone, porphyry and greenstone, which I formerly described to this Society, as extending along the shore of the Tay, from Dundee westward, on the north bank of the river. The southern portion of Fifeshire, contains strata exclusively belonging to the Independent Coal Formation, and forms an interesting part of the coal-

field which occupies the river district of the Forth. An overlying formation of Trap rocks, in the form of conical hills, or irregular patches, covers the rocks belonging to these two formations, and may be observed to the south as well as to the north of the Eden. The city of St Andrew's is situated on the north-eastern extremity of the district occupied by the strata belonging to the independent coal formation. The rocks which occur in the neighbourhood of the city, present a few circumstances in their history, which deserve to be noticed. These I shall briefly detail.

In conformity with the plan pursued by the disciples of the celebrated Werner, I shall state my observations on the rocks which are considered the oldest, and afterwards notice those which appear to have been deposited at a more recent period. The rocks, therefore, which fall to be considered first, are such as belong to the Independent Coal Formation.

The strata in the vicinity of St Andrew's, preserve no regular line of bearing. In a few instances, they are horizontal, but in general they present basin-shaped or saddle-shaped undulations; the strata at the margins of these bendings, incline to the horizon at various angles. The rocks are chiefly Sandstone, Coal, Slate-clay, and Clay-ironstone.

The individual beds are subject to great variation in depth. The beds of sandstone in particu-

lar, sometimes swell out to a considerable thickness, and farther on in their line of bearing, almost disappear. At a place called the Witch-Lake, a bed of sandstone rests upon a horizontal bed of slate-clay. The surface of the bed of sandstone suddenly swells out into a knob, and the slate-clay deposited over this inequality, is seen to rise at a considerable angle on each side in opposite directions, meeting at the top. The inspection of this appearance, will point out the cause of those bendings in the strata to the eastward of the city, and convince the observer, that no other circumstance is required to produce those wavings, than an uneven surface of the inferior beds, and that these inequalities of the surface have been produced by the unequal attraction exerted by the beds already formed, to the matter depositing over them.

I. *Sandstone.*

The sandstone occurs in thick beds, which are distinctly stratified. The grains of quartz are sometimes very minute, and the sandstone is fine-grained. In a few instances, the grains of quartz are large, and the sandstone approaches in characters to conglomerate. The cement of all the sandstones in the vicinity of the city, is easily acted upon by the atmosphere, and hence they are

very liable to decomposition. I observed that those sandstones which contained much mineralized vegetable matter, were the most easily decomposed, and were frequently so friable, that they could be crumbled down between the fingers. The sandstone occasionally contains a little mica, and likewise mineral charcoal, and not unfrequently small globular pieces of iron-pyrites.

II. *Coal.*

A few beds of coal occur in the beds of sandstone. These are, however, of trifling importance, very seldom more than a few inches, and never exceeding a foot in thickness. They are principally slate-coal, containing numerous petrifactions of reeds, flattened and compressed. Thin layers of pitch-coal also occur, both in the slate-coal, and also in the sandstone. In one of the largest beds of coal, I observed globular concretions of sandstone, having the thin layers of coal surrounding them on all sides.

III. *Slate-Clay.*

This rock occurs in beds of various thickness, and of every degree of hardness and density. It

passes distinctly into sandstone, by acquiring small portions of mica and quartz. It likewise passes into limestone and bituminous shale. It includes thin layers of sandstone, and often contains vegetable impressions.

I think it proper in this place to mention a fact not generally known, That slate-clay forms a fertilizing manure to sandy soils, by supplying the requisite portion of aluminous earth. In the neighbourhood of Kirkcaldy, there are several fields of sandy soil which rest upon sandstone. To these fields, slate-clay and bituminous shale have been applied as manure, and with success: they were, previous to this application, unproductive; they now yield good crops of grain and grass. To the west of St Andrew's, there are extensive tracts of soil, principally composed of sand. Were the slate-clay, so abundant among the rocks in the neighbourhood of the city, spread upon these grounds, the most beneficial effects would result from the application. The ground would become firmer, the soil more retentive of moisture, and better able to resist the drought of summer. Ignorance and prejudice may prevent some from following the example of the farmers in the neighbourhood of Kirkcaldy; but I have no hesitation in asserting, that its imitation in many places of the coal districts of Scotland, where such soils and such rocks abound, would greatly contribute to increase the food of man and beast.

IV. *Clay-Ironstone.*

The common claystone occurs in beds from an inch to upwards of a foot in thickness. It contains a few vegetable impressions. The kidney-shaped sub-species, is likewise common. Both of these are included in beds of slate-clay. They are sometimes collected and sent to the Carron Iron-works; but the quantity so procured, is trifling.

In this place, I may take the liberty of observing, that the closet mineralogist may indulge in hypothetical speculations regarding the formation of minerals; but such conjectures will never aid the cause of science, or make us acquainted with the secrets of nature. I have no doubt, but that Dr Hutton, upon examining a specimen of the Septarium iron-ore, was gratified with the idea of having found a convincing proof of the igneous consolidation of fossils, and regarded his explanation of the singular structure of that mineral as the only one which approached the truth. But we hesitate not to say, that had that ingenious philosopher ever attended to the natural history of the Septarium,—had he ever examined it in its clayey bed,—completely surrounded with matter

which presented no marks of igneous influence,— he could not have avoided drawing the conclusion, that since the bed of slate-clay, which contains the septarium, presented no marks of the action of heat, the septarium contained had never been exposed to its influence.

Having thus shortly given an account of the rocks belonging to the independant coal formation which occur in the neighbourhood of St Andrew's, our attention will next be directed to a small portion of the Newest Flœtz-trap formation which covers these rocks.

In many places in Fife, overlying rocks of Basalt, Clinkstone, Felspar, Porphyry-slate, and Claystone, occur resting on the rocks of the old red sandstone, and the rocks of the coal formation. But it rarely happens that distinct sections of these rocks can be found, or the relations which they bear to one another ascertained. On the sea-shore, to the eastward of St Andrew's, a portion of the newest flœtz-trap occurs in such a situation that its geognostic characters can be ascertained with precision.

This formation rests upon beds of sandstone, and the other rocks described above. It extends about 300 yards along the shore, and is connected with a more extensive deposition of the same kind, which stretches inland, but whose history

cannot be easily investigated on account of the thick continuous bed of soil with which it is covered.

V. *Trap-Tuff.*

The principal rock of this formation is trap-tuff, similar in composition to the rock of the same kind which occurs in Arthur's Seat. It contains globular pieces of quartz and granite, which have been water-worn;—likewise fragments of grey-wacke, flœtz-sandstone, and limestone containing petrifactions of entrochi. Small pieces of augite and felspar are likewise contained in it. The inclosed fragments of the older rocks are sometimes of considerable size, measuring two or three entire feet.

It generally happens, that the fragments of the oldest rocks, when observed imbedded in the newer formations, are much rounded and water-worn: Whereas the fragments of the newer rocks, are rather angular, and seem to have suffered less from attrition:—a circumstance which points out with considerable precision the relative antiquity of rocks, and is entitled to a more careful examination than has hitherto been bestowed upon it.

The most curious circumstance which attracted my notice, in examining this bed of tuff, was the rock, which is well known in the neighbourhood

of St Andrew's by the name of the Rock and Spindle, and from which it is distant about a mile and a half.

This rock is about forty feet in height. Towards the base, there is a spherical concretion of basalt, in the form of five or six-sided lengthened pyramids meeting at the apex, giving to the mass a stellate appearance. The mass is likewise divided into concentric layers. The basalt contains crystals of augite, with olivine, and glassy-felspar. This concretion of basalt is surrounded with the tuff, into which it gradually passes; and must have been completely enveloped by it, previous to its partial wasting away by the action of the sea and atmosphere. It may be mentioned in this place, that the regular basaltic columns at the Ely, are a portion of a spherical concretion contained in trap-tuff. Here the concretion is only about ten feet in diameter; at the Ely it is several hundred feet.

In other parts of the tuff, small masses of amygdaloid and basalt occur, leading directly to the conclusion, that the bed is partly a mechanical, and partly a chemical deposit, since these rocks imperceptibly pass into one another.

If the regular forms of basalt induced Dr Hutton to conclude, that they furnished proofs of the action of a central heat, he would have found considerable difficulty in applying his heat to these

inclosed masses of basalt, without fusing the bed of tuff which surrounds them.

He who has the boldness to build a theory of the earth, without a knowledge of the natural history of rocks, will daily meet with facts to puzzle and mortify him.

X. *Meteorological Observations on a Greenland Voyage in the ship Resolution, of Whitby, in* 1811.

By WILLIAM SCORESBY *jun.* M. W. S.

(Read 22d February 1812.*)*

IN the following Table, those Latitudes and Longitudes to which an asterisk is annexed, were ascertained by celestial observations; consequently they may be considered as correct.

The column of Winds, is according to the magnetic meridian.

Meteorological

Meteorological Observations on a

Dates.	Latitude.	Longitude.	Therm. No. of Obs.	Therm. Mean.	Bar. at Noon.	Winds.	Strength of Winds.
					In.		
March 11	56°26′ N.	0°53′ W.	1	47°	30 35	W.erly, to N E	Light or mod. breezes
12	57 16*	0 40 W.	3	49⅔	30 53	N W.erly	Moderate breezes
13	58 13*	0 56 W.	3	50	30 58	Do. or calm	Light airs or calm
14	58 46	0 53	2	42	30 59	Calm or S.erly	To fresh breezes
15	60 4	0 46 W.	2	43	30 43	S W.erly	Strong breezes
16	60 9	1 8 W.	1	51	30 33	Ditto	Moderate breezes
17	Brassa	Sound.	2	48	30 04	S W	Ditto
18			2	47	29 83	S W	Fresh gales
19	Ditto	Ditto	2	47½	29 93	to W	Do. or light breezes
20			2	45½	29 73	to N W.erly	Strong gales
21	Ditto	Ditto	3	44⅔	29 88	Do. and W.erly	Do. to mod. breezes
22			2	50	29 99	N W.erly	Fresh gales
23	Ditto	Ditto	2	48½	30 21	Ditto	Moderate gales
24	60 20	0 38 W.	3	47⅓	30 29	W S W	Fresh gales
25	62 51*	0 46 W.	3	48⅔	30 06	S W	Do. to fresh breezes
26	65 34*	2 9 W.*	3	43⅓	29 42	S W.erly	Strong or hard gales
27	66 56	1 28 W.	3	24⅓	29 29 *a* 29 64 *b*	Ditto to N E	Do. to fresh breezes
28	66 52*	1 45 W.	3	19	30 43	N to W	Calm to strong gales
29	67 0	2 57 W.	3	22	30 31	N and variable	Do. to fresh gales
30	68 17*	3 45 W.	3	17⅔	30 37	E calm	Do. or fresh breezes
31	68 30*	5 02 W.*	2	15⅓	30 26	N E to N N W	Fresh breezes
April 1	69 41*	3 31 W.	3	16⅓	30 00	to N E	Ditto
2	69 40	1 11 E.	3	19⅓	30 24	E.erly variable	Moderate breezes
3	70 22*	3 23 E.	3	28⅔	29 70	S W to N W	Fresh gales
4	70 33*	5 4 E.	3	27⅔	29 84	to N	To fresh breezes
5	70 49	7 15 E.	3	11⅔	29 88	N variable	Fresh gales
6	71 25	10 53 E.	3	18	29 50	to N W & E S E	To stormy
7	71 29	10 39 E.	3	28	29 50	E S E to E N E	Violent gales
8	70 56	10 30 E.	3	28⅓	29 50	E N E	Do. squally
9	70 25*	8 15 E.	3	19	29 89	Do. to N N E	Do. to strong breezes
10	70 32*	6 58 E.	3	10⅓	30 10	N E.rly	Fresh or strong gales
11	70 44	6 26 E.	3	21⅓	30 26	N E to E N E	Ditto
12	70 52*	6 00 E.	3	26	30 24	N E.rly	Ditto
13	70 18*	8 57 E.	3	27⅔	30 14	to N W, variable	Fresh breeze or calm
14	70 52*	8 59 E.	3	28⅓	30 23	Very variable	Strong gales, calm
15	72 36*	13 30 E.	3	30	30 23	S.erly, do.	Fresh gales
16	74 31	16 32 E.	3	35⅓	29 82	S W to W	Do. to strong gales
17	75 34	15 4 E.	3	33	29 82	W to S W	Fresh gales
18	75 34	13 46 E.	3	31⅓	29 66	to W N W	Strong gales
19	75 59	12 50 E.	3	26⅓	30 12	to calm, S W	Fresh gales, calm
20	76 21*	12 0 E.	3	10⅔	30 12	W.erly, N E.rly	Fresh breeze to calm

a 10 Am. 29 29. *b* Noon, 29 64.

Greenland Voyage, 1811.

Dates.	Weather, &c. Aqueous Meteors.	Of the Clouds. Time.	Modifications.	Birds, &c. seen.
March 11	Fine weather, hazy	Morng.	Cirro-stratus.	Young gulls.
12	Morng. cloudy, noonclear	10 Am.	Cirro-stratus.	Ditto and teisties.
13	Fine clear weather	6 Am.	Cirro-cumulus, &c.	Young gulls.
14	Damp weather		Cirro-cumulus, &c.	A land bird, and ditto.
15	Dull cloudy weather	3 Pm.	Cirro-stratus.	Gulls and small birds.
16	Fine weather	2 Pm.	Cirro-stratus.	Ditto.
17	Ditto	Am.	Cirro-stratus, &c.	Ditto, &c. &c.
18	Do. some rain	Am.	Cirrus, &c.	Ditto.
19	Fine weather	Noon.	Cirrus.	Ditto.
20	Showers, hail or rain		Cirro-cumulus, &c.	Ditto, wild ducks.
21	Do. rain or sleet		Cirrus, &c.	Ditto, ditto.
22	Do. and hail	Noon.	Cirrus, &c.	Ditto, ditto.
23	Much do.	Noon.	Cirro-cumulus, &c.	Ditto.
24	Charming fine weather	5 Pm.	Cirro-cumulus, &c.	Young gulls.
25	Ditto	Morng.	Stratus.	Do. fulmars, looms, &c.
26	Hazy weather		Stratus, &c.	Ditto, ditto, and land-bird.
27	Showers, snow	All day	Nimbus.	Many fulmars, gulls, &c.
28	Ditto, aurora borealis		Nimbus, cumulus.	Ditto.
29	Much snow	Am.	Nimbus.	Ditto.
30	Fair, aurora borealis			Fin-whales, fulmars.
31	Fine weather, ditto	Am.	Cumulus.	Ditto, snow-bird, seals.
April 1	Fine clear weather	10 Am.	Cirro-stratus, &c.	Ditto, fulmars.
2	Some snow	All day	Nimbus.	Bottlenoses, fulmars, &c.
3	Much snow	Am.	Nimbus.	Fulmars.
4	Fine cloudy weather			Ditto, rotches, bottlenoses.
5	Snow shwrs. frost-rime	Am.	Nimbus.	Ditto, snow-birds.
6	Snow showers	Am.	Nimbus.	Ditto, bottlenoses.
7	Some ditto	All day	Nimbus.	Ditto.
8	Some hail	All day	Nimbus.	Fulmars, teisties.
9	A few showers snow	Morng.	Nimbus.	Ditto.
10	Some snow showers	Am.	Nimbus.	Ditto, and rotches.
11	Ditto		Nimbus.	Burgomaster, fulmars, &c.
12	Ditto	Am.	Nimbus, cumulus.	Bottlenoses, fin-whale, &c.
13	Fine cloudy weather	Pm.	Cumulus, nimbus.	Ditto, fulmars, &c.
14	Showers of snow		Cirro-stratus.	Ditto.
15	Fine weather	Noon.	Cumulus.	Cetaceous animals, few birds.
16	Thick hazy weather		Stratus.	Fulmars, rotches, &c.
17	Ditto, rain		Fog.	Ducks, looms, &c.
18	Ditto, some snow		Fog.	Ditto, ice-bird, kittywakes.
19	Some snow showers	8 Am.	Cirrus, nimbus.	Ditto.
20	Fine clear weather	10 Am.	Cirrus.	Ditto, razor-backs.

Meteorological Observations on a Greenland Voyage, 1811.

Longitude.	Therm. No. of Obs.	Therm. Mean.	Bar. at Noon.	Winds.	Strength of Winds.	Dates.	Weather, &c. Aqueous Meteors.	Of the Clouds. Time.	Of the Clouds. Modifications.	Birds, &c. seen.
			In.							
11° 0′ E.	3	13	30 19	E by S calm	Chiefly calm	April 21	Fine clear weather	All day	Cirro-stratus.	Narwh. seals, mysticetus, fulms
10 50 E.	3	13	30 30	Calm, N W, &c.	To moderate breeze	22	Some small snow showers	Am.	Cirrus, &c.	Mysticetus, seals, fulmars, &c.
10 20 E.	3	$18\frac{1}{3}$	30 47	N W, calm	To calm	23	Fine clear weather	8 Pm.	Cirrus, &c.	Seals, narw. fulms. burgomaster.
10 45 E.	3	23	30 12	Calm, variable	To fresh gale	24	Much snow	All day	Nimbus.	Ditto.
10 20 E.	3	$20\frac{1}{3}$	29 82	N W to N E.rly	Variable breezes	25	Ditto		Nimbus.	Seals, &c.
10 20 E.	3	9	30 02	N E.erly	Strong gales, &c.	26	Some snow showers	Am.	Nimbus.	Razor-backs, seals, &c.
10 0 E.	2	12	30 07	Ditto	Lt. br. to fresh gale	27	Ditto		Nimbus.	Seals, &c. birds.
8 50′52″E.*	3	$20\frac{2}{3}$	30 17	E N E to North	To light breeze	28	Clear weather	11 Pm.	Stratus.	(Uncom. refract.) whales, narw.
8 50 E.	3	$20\frac{1}{3}$	30 05	to N E and N W	To calm	29	Snow showers		Nimbus.	Whales, narw. seals, &c.
8 48	3	17	30 07	S W to S S E	Fresh breezes	30	Continual snow		Nimbus.	Fulmars and looms.
8 20 E.	3	$16\frac{2}{3}$	30 17	N E to S S E	Moderate breezes	May 1	Snow showers		Nimbus.	Ditto, birds, &c.
8 10 E.	3	$18\frac{1}{3}$	30 17	to East	Ditto	2	Fine weather, little snow	9 Pm.	Cirro-cumulus, &c.	Many common birds.
8 0 E.	3	$21\frac{2}{3}$	29 87	E.rly to S E to	Fresh breezes	3	Snow showers	Am.	Nimbus.	Mysticete, &c. birds.
7 50 E.	3	21	29 75	E N E	Fresh gales	4	Much snow		Nimbus.	Ducks, looms, whales.
7 50 E.	3	19	29 71	Calm, variable	Light airs or calm	5	Snow showers	Am.	Nimbus, &c.	Few birds seen.
7 58 E.	3	$10\frac{2}{3}$	29 78	N W.erly	Fresh breezes	6	Snow showers	Am.	Cirro-stratus, &c.	Whales, fulmars, &c.
8 04 E.	3	9	29 80	N W by N	Strong gales	7	Do. uncryst. snow		Nimbus.	Ditto, snow-birds.
8 10 E.	3	$8\frac{2}{3}$	30 02	N N W	Ditto, strong breezes	8	Do. crystallized		Cirro-cumulus.	Ditto.
8 10 E.	3	22	30 03	S W to N W	Fresh gales	9	Snow showers		Cirro-stratus.	Ditto, snow-bunting.
8 10 E.	3	19	30 08	to North	Do. or mod. gales	10	Showers small snow	Most day	Stratus.	Fulmars, looms, snow-birds.
8 03 E.	3	9	30 15	to N N W	Fresh gales	11	Slight snow showers		Nimbus.	Many common birds.
8 05 E.	3	20	30 00	to S by W or S by E	To light airs, &c.	12	Ditto	8 Pm.	Cirrus.	Whales, narwals, seals.
8 10 E.	3	20	29 63	to S W or W by N	Hard gales	13	Showers snow		Cirro-stratus, &c.	Ditto.
8 15 E.	3	12	29 73	to N W	Strong gales	14	Ditto		Nimbus.	Ditto, looms.
8 56 E.	3	$13\frac{1}{3}$	29 92	N W and var.	Fresh gales	15	Much small snow		Nimbus, stratus.	Razor-backs, looms, &c.
8 59 E.	3	21	29 95	E.rly	Calm, light breezes	16	Snow showers	All day	Nimbus.	Common birds.
9 00 E.	3	21	29 80	N.erly	Moderate breezes	17	Much snow	All day	Nimbus.	Do. sea-horse, (walrus.)
8 46 E.	3	21	30 0	Ditto, variable	Light breezes	18	Ditto		Nimbus.	Walrus, narw. mystic. birds.
8 38 E.	3	23	29 94	Ditto, to S E.rly	Do. and strong gales	19	Small snow showers	Most day	Nimbus.	Narwal, common birds.
8 30 E.	3	21	29 77	S E.rly	Hard gales, &c.	20	Much small snow	Pm.	Nimbus, cirrus.	Common birds.
8 28 E.	3	$22\frac{2}{3}$	29 89	to N E.rly	Calm, light breezes	21	Fine clear weather	Am.&Pm.	Cirrus, &c.	Narw. whales, seals, and ditto.
8 00 E.	3	27	29 68	S E.rly, N E.rly	Moderate breezes	22	A little snow	8 Pm.	Cirrus.	Ditto.
8 16 E.	3	$23\frac{1}{3}$	30 06	N N E, variable	Light breezes	23	Clear fine weather	Am.	Cirrus.	Ditto, fulmars, &c.
8 50 E.	3	25	30 16	to N N W	Ditto	24	Fine weather, cloudy		Stratus.	Ditto.
9 10 E.	3	25	29 98	N W.rly	To fresh breezes	25	Some snow		Nimbus.	Narw. seals, ditto.
9 50 E.	3	$25\frac{1}{3}$	29 90	to North	To strong gales	26	Fine weather			Common birds.
9 30 E.	3	$21\frac{2}{3}$	29 86	N by E	Hard gales	27	Some snow showers	6 Pm.	Cirrus, nimbus.	Ditto.
9 30 E.	3	23	29 90	N by E	Strong gales	28	Cloudy weather			Two whales.
9 27 E.	3	$22\frac{1}{3}$	30 08	N by E	Ditto	29	Fine clear weather		Cirrus.	Bottlenoses, common birds.
5 40 E.	3	22	30 09	to N, variable	Fresh breezes	30	Fine cloudy weather	Morning	Cirrus.	Whales, common birds.
5 35 E.	3	$26\frac{1}{3}$	29 98	to N W.rly	Light breezes	31	Snow showers	Am.	Cirrus.	Many whales, ditto.

Meteorological Observations on a Greenland Voyage, 1811.

Longitude.	Therm. No. of Obs.	Therm. Mean.	Bar. at Noon.	Winds.	Strength of Winds.	Dates.	Weather, &c. Aqueous Meteors.	Of the Clouds. Time.	Of the Clouds. Modifications.	Birds, &c. seen.
			In.							
11° 0′ E.	3	13	30 19	E by S calm	Chiefly calm	April 21	Fine clear weather	All day	Cirro-stratus.	Narwh. seals, mysticetus, fulm
10 50 E.	3	13	30 30	Calm, N W, &c.	To moderate breeze	22	Some small snow showers	Am.	Cirrus, &c.	Mysticetus, seals, fulmars, &c.
10 20 E.	3	$18\frac{1}{3}$	30 47	N W, calm	To calm	23	Fine clear weather	8 Pm.	Cirrus, &c.	Seals, narw. fulms. burgomaste
10 45 E.	3	23	30 12	Calm, variable	To fresh gale	24	Much snow	All day	Nimbus.	Ditto.
10 20 E.	3	$20\frac{1}{3}$	29 82	N W to N E.rly	Variable breezes	25	Ditto		Nimbus.	Seals, &c.
10 20 E.	3	9	30 02	N E.erly	Strong gales, &c.	26	Some snow showers	Am.	Nimbus.	Razor-backs, seals, &c.
10 0 E.	2	12	30 07	Ditto	Lt. br. to fresh gale	27	Ditto		Nimbus.	Seals, &c. birds.
8 50′52″E.*	3	$20\frac{2}{3}$	30 17	E N E to North	To light breeze	28	Clear weather	11 Pm.	Stratus.	(Uncom. refract.) whales, narw.
8 50 E.	3	$20\frac{1}{3}$	30 05	to N E and N W	To calm	29	Snow showers		Nimbus.	Whales, narw. seals, &c.
8 48	3	17	30 07	S W to S S E	Fresh breezes	30	Continual snow		Nimbus.	Fulmars and looms.
8 20 E.	3	$16\frac{2}{3}$	30 17	N E to S S E	Moderate breezes	May 1	Snow showers		Nimbus.	Ditto, birds, &c.
8 10 E.	3	$18\frac{1}{3}$	30 17	to East	Ditto	2	Fine weather, little snow	9 Pm.	Cirro-cumulus, &c.	Many common birds.
8 0 E.	3	$21\frac{2}{3}$	29 87	E.rly to S E to	Fresh breezes	3	Snow showers	Am.	Nimbus.	Mysticete, &c. birds.
7 50 E.	3	21	29 75	E N E	Fresh gales	4	Much snow		Nimbus.	Ducks, looms, whales.
7 50 E.	3	19	29 71	Calm, variable	Light airs or calm	5	Snow showers	Am.	Nimbus, &c.	Few birds seen.
7 58 E.	3	$10\frac{2}{3}$	29 78	N W.erly	Fresh breezes	6	Snow showers	Am.	Cirro-stratus, &c.	Whales, fulmars, &c.
8 04 E.	3	9	29 80	N W by N	Strong gales	7	Do. uncryst. snow		Nimbus.	Ditto, snow-birds.
8 10 E.	3	$8\frac{2}{3}$	30 02	N N W	Ditto, strong breezes	8	Do. crystallized		Cirro-cumulus.	Ditto.
8 10 E.	3	22	30 03	S W to N W	Fresh gales	9	Snow showers		Cirro-stratus.	Ditto, snow-bunting.
8 10 E.	3	19	30 08	to North	Do. or mod. gales	10	Showers small snow	Most day	Stratus.	Fulmars, looms, snow-birds.
8 03 E.	3	9	30 15	to N N W	Fresh gales	11	Slight snow showers		Nimbus.	Many common birds.
8 05 E.	3	20	30 00	to S by W or S by E	To light airs, &c.	12	Ditto	8 Pm.	Cirrus.	Whales, narwals, seals.
8 10 E.	3	20	29 63	to S W or W by N	Hard gales	13	Showers snow		Cirro-stratus, &c.	Ditto.
8 15 E.	3	12	29 73	to N W	Strong gales	14	Ditto		Nimbus.	Ditto, looms.
8 56 E.	3	$13\frac{1}{3}$	29 92	N W and var.	Fresh gales	15	Much small snow		Nimbus, stratus.	Razor-backs, looms, &c.
8 59 E.	3	21	29 95	E.rly	Calm, light breezes	16	Snow showers	All day	Nimbus.	Common birds.
9 00 E.	3	21	29 80	N.erly	Moderate breezes	17	Much snow	All day	Nimbus.	Do. sea-horse, (walrus.)
8 46 E.	3	21	30 0	Ditto, variable	Light breezes	18	Ditto		Nimbus.	Walrus, narw. mystic. birds.
8 38 E.	3	23	29 94	Ditto, to S E.rly	Do. and strong gales	19	Small snow showers	Most day	Nimbus.	Narwal, common birds.
8 30 E.	3	21	29 77	S E.rly	Hard gales, &c.	20	Much small snow	Pm.	Nimbus, cirrus.	Common birds.
8 28 E.	3	$22\frac{2}{3}$	29 89	to N E.rly	Calm, light breezes	21	Fine clear weather	Am.&Pm.	Cirrus, &c.	Narw. whales, seals, and ditto.
8 00 E.	3	27	29 68	S E.rly, N E.rly	Moderate breezes	22	A little snow	8 Pm.	Cirrus.	Ditto.
8 16 E.	3	$23\frac{1}{3}$	30 06	N N E, variable	Light breezes	23	Clear fine weather	Am.	Cirrus.	Ditto, fulmars, &c.
8 50 E.	3	25	30 16	to N N W	Ditto	24	Fine weather, cloudy		Stratus.	Ditto.
9 10 E.	3	25	29 98	N W.rly	To fresh breezes	25	Some snow		Nimbus.	Narw. seals, ditto.
9 50 E.	3	$25\frac{1}{3}$	29 90	to North	To strong gales	26	Fine weather			Common birds.
9 30 E.	3	$21\frac{2}{3}$	29 86	N by E	Hard gales	27	Some snow showers	6 Pm.	Cirrus, nimbus.	Ditto.
9 30 E.	3	23	29 90	N by E	Strong gales	38	Cloudy weather			Two whales.
9 27 E.	3	$22\frac{1}{3}$	30 08	N by E	Ditto	29	Fine clear weather		Cirrus.	Bottlenoses, common birds.
5 40 E.	3	22	30 09	to N, variable	Fresh breezes	30	Fine cloudy weather	Morning	Cirrus.	Whales, common birds.
5 35 E.	3	$26\frac{1}{3}$	29 98	to N W.rly	Light breezes	31	Snow showers	Am.	Cirrus.	Many whales, ditto.

Meteorological Observations on a

Dates.	Latitude.	Longitude.	Therm. No. of Obs.	Therm. Mean.	Bar. at Noon.	Winds.	Strength of Winds.
					In.		
July 13	73°10′	9°25′	3	40⅓	29 87	To S S E	To fresh breeze
14	72 17	7 57	3	41	29 94	Variable	To calm
15	72 10	6 27	2	42	30 05	N W to S W	Light breeze, or ditto
16	71 24	3 57	3	43	29 89	S.erly, variable	Fresh breeze, &c.
17	70 36	2 40	3	43	29 94	N W, variable	Mod. breeze, calm
18	70 30*	2 05	3	46⅓	29 97	S.erly	Calm, to mod. breeze
19	70 15*	1 05 W.	3	46⅓	30 01	Ditto, &c.	To light breeze
20	69 31	3 50	3	46⅔	30 00	S.erly	Mod. or fresh breeze
21	68 43*	4 35	3	46⅔	30 07	to S W	Fresh gales, &c.
22	68 28	4 46	3	46⅔	30 02	S.erly, variable	Mod. or fresh gales
23	66 48	5 11	3	47	29 54	Ditto	To strong gales
24	66 35′31″*	7 57	3	47	29 46	Ditto	Fr. br. and fr. gales
25	65 30	8 28	3	47⅓	29 33	to N.erly	To strong gales
26	63 3*	7 9′45″ *	3	48⅔	29 95	N by W	To fresh gales
27	61 33	4 43	3	52	30 02	N W.erly	Moderate breezes
28	60 56	3 48	3	55⅓	29 03	S.erly	Ditto or calm
29	60 00*	1 50	3	56⅓	30 09	to W.erly	Light or mod. breeze
30	58 39*	1 30	3	61½	30 25	W N W or S W	Ditto
31	58 14*	1 46	2	66	30 15	N W to S E	Ditto, calm
August 1	57 37*	1 30	3	61⅓	30 10	S or S W	Fresh breeze
2	57 09	1 44	2	60½	29 82	S to S W by S	Fresh gales
3	56 37	2 17	2	56⅔	29 76	S.erly, variable	To calm
4	56 14	1 35	3	63	29 78	S.erly, variable	To fresh breeze
5	55 30	0 54	3	67⅓	29 80	W.erly	Moderate breeze
6	54 50	0 26	2	65½	29 63	S W to S E	To light breeze
7	Whitby Harbour		2	66	29 60	N N W, W	Fresh or mod. breeze

Greenland Voyage, 1811.

Dates.	Weather, &c. Aqueous Meteors.	Of the Clouds. Time.	Of the Clouds. Modifications.	Birds, &c. seen.
13	Fog showers		Fog.	Fulmars.
14	Much fog		Fog.	Razor-back and fulmars.
15	Ditto		Fog.	Ditto and looms.
16	Some rain	Noon.	Cirro-cumulus, &c.	Several ditto, looms, fulmars.
17	Fog		Fog.	Some whitish fulmars.
18	Ditto	11 Am.	Cirro-cumulus, &c.	Young gulls or kittywakes.
19	Much fog	11 Am.	Cirro-stratus.	Ditto, seal.
20	Ditto		Fog.	Ditto, fulmars.
21	Rain or fog		Fog.	Fulmars.
22	Rain or fog	3 Pm.	Cirro-cumulus, &c.	Ditto.
23	Much rain or fog		Fog.	Several fulmars.
24	Fog or rain	3 Pm.	Cirrus, &c.	Ditto.
25	Ditto		Nimbus.	Ditto.
26	Cloudy	11 Am.	Cirro-cumulus, &c.	Fulm. arc. gull, loom, solan-geese.
27	Fine cloudy weather	Am	Nimbus.	Young gulls, ditto.
28	Some rain	10 Pm.	Cirrus.	Ditto, &c.
29	Showers of rain	2 Am.	Nimbus, &c.	Ditto.
30	Ditto		Cirro-cumulus.	Young gulls.
31	Fine clear weather	Noon.	Cirro-cumulus, &c.	Cod-fish, turbot, skate, &c.
1	Cloudy weather	Noon.	Cirro-cumulus, &c.	Gulls, mackrel.
2	Showery	Pm.	Cirro-stratus, &c.	Ditto.
3	Showers rain	Am.	Nimbus.	Gulls, gurnards.
4	Much rain	Noon.	Cirrus, &c.	Gulls, looms.
5	Some rain	Pm.	Cirro-cumulus, &c.	Gulls.
6	Some rain	Am.	Nimbus, cirrus.	Ditto.
7	Showers rain	Am.	Cirrus.	Ditto, &c.

Having now given a meteorological register, carefully kept by myself, on a voyage from Whitby to Greenland, and back, I may be permitted to annex a few remarks on the great utility of the Barometer and Thermometer at sea. When these instruments are well attended to, they will seldom fail to enable us to predict any great atmospheric change: and if the oscillations of each instrument be *connectedly* studied, not only the strength of the coming wind, but its direction and continuance may be guessed at, and with very considerable accuracy. An extract from my private journal will strikingly prove the truth of the above assertion.

"On April the 5th 1811, latitude 70°49′, and longitude 7°15′ E, the barometer had stood at 29.88, for about thirty-five hours; the mean of three observations of the thermometer during the day, was $11\frac{2}{3}$°, the wind blowing a fresh gale from the northward. At noon, on the following day, we had a moderate breeze of wind at north-west, which, towards evening, increased to a fresh gale, exceedingly variable and squally, accompanied with thick showers of *flaky* snow. At 3 PM. the thermometer had risen to 17°, and at 6 PM. to 27°. This remarkable rise of 17 degrees of temperature in nine hours, made me suspect, a south-east wind was about to prevail, and because the barometer had fallen to 29.50, a severe storm might be expected. Since the barometer stands highest on

E. or S E. winds, had it not fallen we should have expected a storm, on its veering from N W. to the opposite quarter; but, when accompanied by a fall of near four-tenths of an inch, a most violent gale would be likely to ensue. I walked the deck somewhat alarmed at the awful appearance of the sky, in the short intervals of the showers. At one time, a strong light, like that seen reflected on the horizon by the rising or setting sun, appeared stretching from the N N E, to the E S E, but more correctly corresponding with the phenomenon of the *ice-blink*, which is a strong light reflected from the ice into the atmosphere above it, and in clear weather is almost always seen when at the distance of fifteen or twenty miles from any compact body of ice. This white light, I soon ascertained, did not proceed from any ice*. The sun was neither in the same quarter nor opposite.

"In the midst of a thick shower, (wind still N W to N N W,) I observed the snow to clear away to lee-ward, which assured me of the wind being about to *shift*. Immediately all hands were ordered on deck to attend the sails, and every man at his station, awaited the event. In about ten

* Some time afterwards, when mentioning this circumstance to an old Greenland commander, he told me he had himself more than once seen the phenomenon I described, and always considered it as a prognostic of a storm; at the same time, its position pointed out the quarter from whence it would commence.

minutes, a shivering of the sails was observed, and instantly afterwards *they were taken flat aback*; the wind, whilst blowing a fresh gale, had veered from N N W, to E S E. We steered by the wind N E.ward for an hour and a half, when the snow began to abate, and the wind of a sudden so increased, that we were obliged again to raise all hands to take in, and still further reduce the sails: with our utmost exertions, we were but just able to save them from blowing away. The wind now blew so furiously, that all sails were furled but a small storm-topsail, and close-reefed main-topsail; and which, though new sails, we often expected could not withstand the fury of the tempest. Being in the vicinity of the ice to the N.ward, we *wore* the ship, and *lay to* under those two small sails for sixty hours. The sea ran tremendously high. We carried a boat at each quarter of the ship, suspended by the davits, much above the deck; on the second day of the storm's continuance, a heavy sea struck the ship, and with dreadful violence came on deck, but happily did no serious damage. It lifted up the weather quarter boat, and had nearly thrown it upon deck; and the lee boat, with another in the chocks, were completely filled with water. It lifted an eighteen pounder caronnade quite out of its place, and washed away or stove in the quarter and waist-boards, fore and aft.

"During the whole continuance of this gale, the barometer never varied one-fiftieth of an inch."

XI. *A Meteorological Journal kept during a Greenland Voyage,* 1812.

By William Scoresby *jun.* M. W. S.

(Read 22d February 1812.)

In the following Table, the three columns titled *Latitude, Longitude,* and *Barometer,* refer to the time of 12 o'clock mid-day. The Latitudes and Longitudes which have this mark (*) annexed, are from observations of some of the heavenly bodies: the rest are from the ship's reckoning. The directions of the Winds are from the magnetical card.

In the last column, *Animals, &c. seen,* I have, in general, used the vulgar names of the different animals, not being certain of the exact situation of some of them in the classification of Linnæus, especially of the cetaceous animal vulgarly called the Razor-back, from the angular form of its back, somewhat like the roof of a house. It is the largest of the whale tribe inhabiting the Greenland Seas, growing to the length of near 100 feet; its body, however, is much more slender than that of the common whale. It corresponds tolerably well with the generic character of the *Physalus.* The *White Whale* seems to be the *Physeter Macrocephalus albicans.*

A Meteorological Journal of a

Dates.		Latitude.	Longitude.	Therm. No. of Obs.		Bar. at Noon.	Winds.	Strength of Winds.
						In.		
May	1	74°30′ N.	15°13′ E.	3	25	30 20	N W to N	Fresh gales
	2	75 23	14 25	3	23	30 37	N E to S E.rly	Mod. to fresh gale
	3	75 35	10 43	3	13	29 45	to S E & E by S	Very hard gales
	4	74 36	10 0	3	13	29 89	E b N to N E b E	Hard gales
	5	73 41	10 40	3	12	29 75	to N E	Ditto
	6	73 10	10 18	3	17	29 64	N E	Ditto
	7	72 58	10 19	3	22	29 89	to N N E	Fresh gales
	8	73 33	10 21	3	24	29 94	to N N W, var.	Fresh breezes
	9	73 57	10 21	3	25	30 05	Very variable	Light breezes
	10	74 23 15″	9 37	3	27	30 03	N W.rly, var.	Do. or calm
	11	75 36*	8 8	3	31	29 90	S E by E, E.rly,	Fresh gales
	12	75 38	8 20	3	27	29 83	N E, N N E	Light to strong br.
	13	75 52*	9 20	4	23	29 77	N.rly, variable	Strong breeze
	14	76 12	10 20	4	23	29 88	W.rly, S.rly	Moderate breezes
	15	76 15*	9 0	3	32	29 70	S to S E	Fresh breezes
	16	76 20	9 40	3	30	29 50	N E.erly	Strong gales
	17	76 7*	9 30	3	21	29 85	to N N W	Hard gales
	18	76 37*	10 45	3	22	29 75	Very variable	Moderate gales
	19	76 30	10 45	3	20	29 93	N by W	Strong gales
	20	76 30	10 30	3	18	30 03	N by W	Fresh or strong gales
	21	76 30	10 00	3	19	29 80	N by W	Strong gales
	22	76 20	10 00	3	20	29 66	N by W	Very strong gales
	23	76 10*	10 0	3	25	29 90	to N W by N	Strong gales
	24	76 5	10 0	3	27	30 00	N W by N, var.	To light breeze
	25	75 58*	10 0	4	30	30 06	N.rly, variable	Light breeze
	26	75 50*	9 40	3	33	30 13	N E.rly	Ditto
	27	75 57	9 0	3	29	30 16	Variable	Inclinable to calm
	28	75 50	9 20	3	29	30 28	S.rly, S W.rly	Ditto
	29	76 0	9 20	3	29	30 28	S.rly, S W.rly	Ditto
	30	76 20	10 0	3	29	30 32	S E.rly	Ditto
	31	76 30	10 50	3	28	30 32	S E, S W.erly	Ditto
June	1	77 14	9 5 E.	3	30	30 37	S W to W	Moderate gales
	2	78 15	5 27	3	31	30 37	S.rly, variable	Mod. br. and ditto
	3	78 50	7 0	3	31	30 34	S E.rly, &c.	Strong gales
	4	78 30	5 30	3	32	29 96	S E by E	Moderate gales
	5	78 30	5 30	3	33	29 90	S.rly	Fresh breeze
	6	78 26	5 15	3	34	29 87	S.rly, variable	Light breeze
	7	78 00	5 45	3	33	29 87	Calm, S.rly	Calm, fresh breeze
	8	78 00	6 45	3	25	30 10	N to W	Strong gales
	9	78 00	6 30	3	25	30 00	to W by N	Light breeze
	10	77 54	6 15	3	29	29 80	N.rly, variable	Fresh breeze

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Dates.		Weather, &c. Aqueous Meteors.	Of the Clouds. Time.	Of the Clouds. Modifications.	Animals, &c. seen.
May	1	Cloudy weather		Not distinct.	Ducks, fulms, looms, rotches, &c.
	2	Do. much snow			Common birds, razor-backs.
	3	Snow showers			Fulmars only.
	4	Ditto			Fulmars, rotches.
	5	Ditto			Ditto.
	6	Ditto		Frost-rime.	Ditto.
	7	Ditto		Nimbus.	Ditto.
	8	Ditto		Nimbus.	Ducks, fulmars, rotches.
	9	Much snow		Nimbus, cirrus.	Many ducks, burgomasters, &c.
	10	Snow showers	Am.	Cirrus, nimbus.	Many seals, ditto, birds.
	11	Ditto		Nimbus.	Common birds, 2 whales.
	12	Cloudy weather		Ice-blinks.	2 Whales, seals, common birds.
	13	Ditto		Ditto.	2 or 3 whales, ditto.
	14	Do. snow		Ditto.	1 whale, narws. seals, snowbirds.
	15	Ditto		Dense clouds.	Seals and common birds.
	16	Much snow	Am.	Nimbus.	Ditto, ditto.
	17	Cloudy	Pm.	Nimbus.	Ditto, ditto.
	18	Continual snow	All day.	Nimbus.	A whale.
	19	Thick snow		Frost-rime.	Narwal, seals, common birds.
	20	Much snow		Ditto.	A whale, common birds.
	21	Ditto		Ditto.	ditto.
	22	Ditto	All day.	Nimbus.	No whales, ditto.
	23	Some snow		Nimbus, &c.	Common birds.
	24	Fine weather		Nimbus, &c.	
	25	Ditto		Nimbus, &c.	Narwals.
	26	Ditto		Nimbus.	Ditto, whales.
	27	Ditto	Am.	Cirrus, &c.	Some whales, narwals, &c.
	28	Ditto	Am.	Cirro-cumulus.	Ditto, seals, common birds.
	29	Ditto		Cirro-cumulus, &c.	Ditto, ditto.
	30	Ditto	All day.	Cirro-cumulus, &c.	Common birds.
	31	Ditto		Cirro-cumulus, &c.	Ditto.
June	1	Cloudy weather			Common birds.
	2	Much snow		Ice-blinks.	Seals, some whales.
	3	Snow showers, fog		Nimbus.	ditto.
	4	Fog showers			
	5	Thick fog, rain		Fog.	Ditto.
	6	Constant fog			Common birds.
	7	Fog showers			White whales, narwals, seals, &c.
	8	Fine clear weather	Pm.	Cirro-cumulus.	Several whales.
	9	Ditto		Cirro-cumulus, &c.	Many whales.
	10	Snow showers		Cirrus, nimbus.	Many whales, narwals, ducks.

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Dates.	Latitude.	Longitude.	Therm. No. of Obs.		Bar. at Noon.		Winds.	Strength of Winds.
					In.			
June 11	78°44′ *	6°30′	4	25	29	77	N E.rly	Strong gales
12	78 58	6 30	4	24	29	88	N E to N N E	Fresh breezes
13	78 56	6 30	3	26	29	68	N.erly, variable	Strong gales
14	78 50	6 30	3	27	29	77	E N E, N N E	Strong gales
15	78 40	6 15	3	30	29	80	N N E	To fresh gales
16	79 26	6 45	3	27	29	77	N E by N	
17	78 30	6 00	4	29	29	86	N W	Fresh breezes
18	78 20	6 00	3	32	29	80	W, S W, E	Light breezes, calm
19	78 10	6 00	3	32	29	78	E, N E.rly,	Calm; fresh breeze
20	78 17	6 00	2	26	29	79	N N E	Fresh breezes
21	78 25	6 30	3	29	29	70	N N E	Strong gales
22	78 32	6 30	3	28	29	74	N N E	Fresh gales
23	78 30	6 15	3	30	29	80	Variable	Light breezes
24	78 5	6 35	3	33	29	55	Ditto	To strong gales
25	78 9*	6 45	3	32	29	95	N E.rly	Fresh gales
26	78 10	6 40	3	33	29	97	N.rly	Light breezes
27	77 59*	6 07	2	34	29	86	N N E, N N W	Fresh breezes
28	78 00	6 00	3	36	29	65	N.rly	Moderate breezes
29	77 48	6 50	3	34	29	55	N.rly	To fresh breeze
30	77 30	6 45	3	33	29	50	Very variable	Moderate breezes
July 1	77 54	6 15 E.	3	35	29	45	E S E to E N E	Ditto
2	78 9*	6 30	3	35	29	77	E.rly, variable	To fresh breezes
3	78 20	6 30	3	33	29	40	N E.rly	Strong gales
4	78 18	6 40	3	32	29	42	N and variable	Moderate or fresh br.
5	78 10	6 45	3	32	29	72	S W	To strong breeze
6	78 5	6 30	3	32	29	90	S W and W.rly,	Fresh or moderate br.
7	78 58	6 45	3	33	30	00	W.rly	Calm or light airs
8	77 40	6 10	3	32	29	90	W S W, S W	Moderate or fresh br.
9	77 30	6 00	3	32	29	84	S W to N N E	Ditto
10	77 30	6 00	3	32	29	81	N N W to N	To fresh gales
11	78 00	5 30	4	32	29	90	N N E to N N W	Strong gales
12	77 56	5 30	4	33	29	87	N N W to N E	Ditto
13	77 46*	5 27	3	37	30	03	N E to N	Fresh breezes
14	78 20	6 25	3	33	29	90	N to N E by N	Strong gales
15	77 40	5 20	3	33	29	76	N E.rly	Ditto
16	77 45	5 30	3	32	29	60	N E to E & S E	Mod. to strong gales
17	77 50*	5 7	3	31	30	10	S E	Strong gales
18	77 59	5 00	3	32	30	32	to E & N N E	Moderate breezes
19	78 00	5 00	3	32	30	12	N & variable	Light airs, calm
20	78 00	5 00	3	35	30	13	S W.rly	Moderate or fresh br.
21	78 00	4 50	3	34	30	20	S.rly to E	Strong breezes
22	78 00	4 30	4	34	30	24	E.rly	Fresh breezes

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Dates.	Weather, &c. Aqueous Meteors.	Of the Clouds. Time.	Of the Clouds. Modifications.	Animals, &c. seen.
June 11	Fine weather	All day	Cirro-cumulus, &c.	Many whales.
12		All day	Cirrus, &c.	Ditto.
13	Fine clear weather	Noon.	Cirrus, &c.	2 whales, razor-backs, com. birds.
14			Cirrus, &c.	Common birds.
15	Some snow	All day	Cirro-cumulus, &c.	3 Bears.
16	Cloudy weather		Ice-blinks.	Some few birds.
17	Showers, snow	All day	Nimbus.	Some whales, narwals, seals.
18	Snow showers		Fog.	Razor-backs.
19	Much snow		Nimbus.	A few whales, razors, a bear.
20	Cloudy weather		Nimbus.	Ditto.
21	Fog or snow		Nimbus.	1 Whale, 1 narwal, some birds.
22			Nimbus.	Some whales.
23	Snow showers		Nimbus.	A few whales, narwal, &c.
24	Fog or snow		Nimbus.	Several large whales.
25	Fine clear weather	Pm.	Cirro-cumulus, &c.	Ditto, and narwals.
26	Ditto	Am.	Cirrus, &c.	Some large whales.
27	Showers snow	Am.	Nimbus.	Some birds.
28	Fog or snow		Cirro-cumulus, &c.	Some whales, narws. birds, &c.
29	Thick fog		Fog.	Two whales.
30	Thick snow	All day	Nimbus.	Two whales.
July 1	Snow and fog	All day	Nimbus, fog.	Some whales, seals, com. birds.
2	Thick fog	Noon.	Cirro-cumulus.	Razor-backs, sharks, whales, &c.
3	Much snow			Ditto, some whales, seals, &c.
4	Snow showers		Cirro-cumulus, &c.	Several whales.
5	Some ditto		Nimbus.	Ditto, seals, razor-backs.
6	Snow & fog shwrs.		Nimbus.	Ditto, ditto, narwals.
7	Ditto	All day	Nimbus.	Ditto, ditto.
8	Cloudy or fog		Fog.	2 or 3 whales.
9	Fine hazy weather		Do. showers.	Several whales.
10	Fine weather	Pm.	Cirro-stratus, &c.	Many large whales, seals, &c.
11	Snow showers		Nimbus, &c.	Whales, razors, seals, narwls. &c.
12	Snow showers	All day	Nimbus, &c.	Ditto, ditto, ditto.
13	Fog showers	Am.	Cirrus, &c.	Common birds.
14	Ditto	Am.	Cirrus, &c.	2 Whales, 1 razor, seals.
15	Ditto, or snow	All day	Fog, &c.	Some whales, many seals.
16	Thick fog			3 ditto, thousands of seals
17	Fog or snow shwrs.			Common birds, ditto.
18	Ditto	Am.	Cirrus, &c.	Several whales.
19	Ditto		Fog, &c.	Many whales, seals, narwals.
20	Fog showers	Pm.	Cirro-cumulus, &c.	Seals plenty, two sea-parrots.
21	Fine weather	Pm.	Cirro-cumulus, &c.	Many whales, narws. seals, bears.
22	Hazy weather	Pm.	Nimbus.	Whales, ditto, ditto, ditto.

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Dates.		Latitude.	Longitude.	Therm. No. of Obs.		Bar. at Noon. In.	Winds.	Strength of Winds.
July	23	78°00′	4°30′	4	38°	30 25	S E	Light airs
	24	78 6*	5 15	3	35	30 15	S S W.erly	Ditto
	25	78 20	6 5	3	35	30 12	S S W, W.rly	Calm chiefly
	26	77 44	6 39	3	32	30 00	W.rly, N E	Strong breezes
	27	76 4	6 48	3	33	30 00	N E.rly	Moderate breezes
	28	73 26	6 45	3	38	29 80	E N E	Fresh gales
	29	71 18	3 45	3	40	29 70	E N E.rly	Strong gales
	30	70 3	2 5	3	41	29 70	E.erly variable	Moderate breezes
	31	68 24*	1 7	2	44	29 87	Calm, N W.erly	Calm, fresh breeze
August	1	67 32	1 38 E.	3	48	30 00	S W to W.rly	Light airs
	2	66 47	1 17′30″W.*	3	50	30 14	S to S E.rly	Moderate breezes
	3	65 14	2 17 W.	3	50	29 98	S E.rly	Fresh breeze
	4	64 35	2 42	3	50	30 04	W to S W.rly	Light breeze
	5	64 19	4 1	3	50	29 87	S W or W.rly	Strong gale
	6	63 3′29″*	3 16	3	50	30 17	W variable	Light breeze
	7	62 8	3 50	3	51	30 24	N.rly, variable	Light or mod. breeze
	8	60 13*	3 50	3	53	30 17	N.erly, do.	Strong breeze
	9	58 57	1 55	3	53	30 10	N E.rly	Strong gales
	10	56 56	0 42	3	54	30 13	N E to N N E	Moderate breeze
	11	55 8	1 12	3	54	30 20	N E.rly	Light breeze
	12	54 31	0 30	3	58	30 22	N E.rly	Ditto
		Whitby Roads.						

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Dates.	Weather, &c. Aqueous Meteors.	Of the Clouds. Time.	Of the Clouds. Modifications.	Animals, &c. seen.
July 23	Haze or fog		Nimbus, &c.	1 Whale, common birds.
24	Fine weather, fog	Am.	Cirro-cumulus, &c.	2 Whales, many narws. 3 bears.
25	Thick fog		Fog.	Common birds and seals.
26	Ditto			Many fulmars.
27	Ditto			Ditto, burgomasters.
28	Cloudy weather		No distinct modn.	Ditto.
29	Rain		Rain.	Ditto.
30	Thick fog showers		Fog.	Ditto.
31	Thick fog			Ditto.
August 1	Charming fine wea.	Pm.	Cirro-cumulus, &c.	Bottlenoses, gulls, fulmars.
2	Some rain	All day.	Cirrus, &c.	Many gulls, arc. gulls, bottlenoses.
3	Cloudy	Noon.	Nimbus, &c,	Ditto, ditto, ditto.
4	Fog	Pm.	Cumulus, &c.	Ditto, fulmars.
5	Cloudy, rain, fog			Many gulls.
6	Fine weather	Pm.	Cirro-stratus, &c.	Many gulls.
7	Thick fog		Fog.	Mollusca, sea-parrots, gulls, &c.
8	Cloudy weather	Pm.	Stratus, &c.	Ditto, solan-geese, ditto, &c.
9	Fine clear weather	Am.	Cirrus.	Gulls, ditto.
10	*Sea luminous. Light*	*ning.*		Gulls, fulmars.
11	Charming fine wea.	Am.	Cirrus, &c.	Gulls, willocks.
12	Ditto	Pm.	Cirrus, &c.	Gulls, willocks, &c.

XII. *Analyse du Spath perlée, (Chaux carbonatée ferrifère perlée d'Haüy.)*

By W. Hisinger, Esq. Stockholm.

(Read 20th November 1813.)

Parmi les substances minerales qui demontrent la nécessitée de l'application de l'analyse chimique à la classification systematique des mineraux, on pourra compter avec raison ceux que M. Haüy, dans son Traité de Mineralogie, a rangé sous l'espèce du Chaux carbonatée ferrifère avec manganèse, dans laquelle se trouve réuni le Fer spathique, le Spath brunissant (Braunspath), et sa variétée le Spath perlée. Dans le système de M. Werner, ces deux substances sont considerés comme differentes, et le Fer spathique est placé dans la classe des Mines de Fer. Plusieurs analyses de Klaproth, C. Descotils, Bucholz, &c. ont dejà consideré le Fer spathique comme une Mine de Fer carbonatée,

et une analyse de M. Klaproth *, place le Braunkalk sous la Chaux carbonatée magnésifère. Aussi les experiences suivantes prouveront que le Spath perlée, jugé d'après ses parties constituantes, doit être réuni à l'espèce de Chaux carbonatée magnésifère.

Le spath perlée qui vient d'etre l'objet de cet examen, est de couleur blanche, tirant un peu sur le jaunâtre. La surface est drusique, d'un éclat et de reflets nacrés, formant une croute sur d'autres cristaux. Dans l'interieur il est seulement chatoyant. Une goutte d'acide nitrique y laisse une tache jaunâtre. Le local inconnû, (Freiberg ?)

a.—10 grammes de spath perlée traité au feu pendant $\frac{3}{4}$ d'heures, ont perdu 4.460 grammes. La couleur s' est changé en grisâtre, et avee le borax il a donné au feu du chalumau une verre de couleur rouge-jaunâtre.

b.—10 autres grammes de la même substance non rougi au feu, mais reduite en poudre, ont été dissoute avee effervescence dans l'acide muriatique étendu d'eau. Dans la dissolution, dont la couleur étoit verdâtre, l'ammoniaque caustique occassionnoit un précipité verdâtre d'oxidule de fer, qui pendant le lavage sur le filtre devenoit brun foncé. Ce précipité fut redissout dans l'acide muriatique mêlée d'acide nitrique. La dissolution fut etendu d'eau, neutraliséepar l'ammoniaque caustique, et pre-

* Beiträge, t. 4.

cipitée par le benzoate d'ammoniaque. Le benzoate de fer, décomposé par le traitement au feu, laissoit 0.34 gr. oxide de fer. La liqueur neutralisée à froid par le carbonate de potasse, deposoit un précipité blanc, jaunissant par la dessication, devenant noir au feu, et pesant 0.07 gramme. Au reste, il se comportoit comme l'oxide pur de mangane. Cela fait, ayant ajouté à la liqueur en ebullition du carbonate de potasse en excès, on obtint un autre précipité, qui rougi au feu, devenoit grisâtre, pesoit 0.06 gramme, et qui fut enfin décomposé en 0.03 gramme d'oxide de mangane et 0.03 gr. de la magnésie.

c.—La dissolution muriatique, qui dans l'experience precedant (*b*) avoit été précipitée par l'ammoniaque caustique, fut un peu concentrée par l'évaporation, et après etre mis en ebullition mêlé avec du carbonate de potasse basique en excès jusqu' à la decomposition complette du sel ammoniacal. Dans cet operation on obtenoit un précipité blanc, un peu gelatineux au commencement, pesant 4.886 grammes, après etre lavé et traité à un feu très vif pendant une heure, dans un creuset decouvert. La couleur etoit grisatre. Il fut dissout au froid, et sans effervescence, dans l'acide nitrique étendu avec 30 parties d'eau, qui laissoit quelques flocons bruns d'oxide de mangane, pésant 0.05 gramme après etre rougi au feu.

d.—En ajoutant un peu de muriate d'ammoniaque à la dissolution, separé de mangane, elle

fut précipitée par le carbonate d'ammoniaque en excès, qui en séparoit le carbonate de chaux, dont le poids, après avoir été exactement et fortement séché, montoit à 4.96 grammes, équivalent à 2.797 grammes de la chaux caustique. La dissolution du sel triple contenu dans la liqueur restante, fut mis en ébullition, et decomposée par la potasse caustique. Le précipité, qui étoit blanc, se comportoit en tout comme la terre de magnésie, et contenoit les autres 2.084 grammes de la masse précipité en *c*.

Il résulte de l'analyse ci-dessus, que 10 grammes de spath perlée sont composés,

De la chaux, *d*	2.797
Magnésie, *b*, *d*.	2.114
D'oxide de fer, *b*.	0.340
D'oxide de mangane, *b*, *c*.	0.150
Acide carbonique, *a*.	4.460
	9.861 grammes.

Ou, que 100 parties contiennent,

Chaux,	27.97	
Magnésie,	21.14	
Oxide de fer,	3.40	
Oxide de mangane,	1.50	
Acide carbonique,	44.60	
		98.60
Perte,		1.40
		100.00

Köping en Suede,
le 15 *Avril* 1813.

XIII. *Outline of the Mineralogy of the Pentland Hills.*

By Professor JAMESON.

(Read 16th February 1811.)

SECTION I.

THIS beautiful group of hills, is situated in the counties of Mid-Lothian and Peebles. The nearest point is distant from Edinburgh, in a straight line, not less than four miles. It stretches from south-west to north-east, and extends from Dunsyre Hill to Kirkyetten Craig. As we approach its south-western extremity, it becomes gradually lower, and terminates in the flat country, which extends from Dunsyre Hill to the east bank of the river Clyde; but immediately to the south, it is connected with the great southern

alpine land of Scotland, by means of Mendeck Hill, the Dolphington Hills, and other hills. Its north-eastern extremity is lofty, in some places precipitous and cliffy, and the most prominent point is Kirkyetten Craig. The breadth of the group varies from three to eight miles: the hills of which it is composed, exhibit considerable variety in shape: those to the west of the river Esk are generally more or less round-backed, whereas those to the east of the same boundary, besides the round-backed shape, display also the more elegant conical and tabular forms: and its height is considerable, several of the hills being 1600 or 1700 feet above the level of the sea.

In this paper, it is my intention to describe only a part of the group, viz. that portion of it which extends from the bridge of Caerlips to Kirkyetten Craig, a distance of rather more than eight miles *; and which includes the whole of that part of the Pentlands contained in Mid-Lothian.

The south-western extremity of this portion of the group, joins with Caerlips Hill, Mount Hill, and other neighbouring hills: its north-eastern extremity is composed of several hills irregularly grouped together, with small valleys between, and of which, the Kirkyetten Hills are the most

* This part of the group is laid down in Laurie's map of the county of Mid-Lothian, published in 1763.

considerable. The space between the two extremities, is occupied by a double range of hills; which are separated from one another, in the first part of their course, by a high muirish plain, which extends from the source of the North Esk river to *Habbie's How*; and, in the remainder of their course, by a beautiful pastoral valley, through which Logan Water flows. A small range of low, generally round-backed hills, skirts the south side of the group, from Glencross Bridge, nearly to Caerlips; and several small hills skirt the group from Swanston, by Bonailly to Kinleith. The hills vary considerably in height. The highest hills in the group, are Black Hill and Caernethy Hill, whose summits are 1700 feet above the level of the sea; Kirkyetten is 1544 feet above the level of the sea; Castlelaw, 1390 feet; and Spittal-Law, 1360 feet.

The hills also vary considerably in form. The most common shape is the *round-backed*, of which we have examples in the Kirkyetten Hills, Turnhouse Hill, Mucks Rig, Spittal Hill, Cock Rig, East Cairn Hill, Hare Hill, Black Hill, and Bald or Bield Hill. Others are *conical*, as the Kipps, Caernethy, Castlelaw, &c.: and some are *tabular*, as one of the tops of the hill named East Side Black Hill. The acclivities of the hills, although in general steep, are so covered with grass, as to afford excellent pasture: few cliffs occur, and none are of great height or extent: the most remarkable are those of Kirkyetten facing Edinburgh, and at Habbie's

How, over which the Logan Water is precipitated. The mode of connection of the individual hills, varies; in general they are connected by their summits or their acclivities.

The principal valleys in this portion of the group, are those of the Logan Water, and of the North Esk river. The Logan Water rises near the foot of the hill named Cock Rig, and runs for about a mile and a half, in a north-eastern direction, through the high muirish flat already mentioned, being bounded on the north side by Hare Hill, and on the south side by Spittal Hill and the Kipps, when it falls over a rocky precipice about eighty feet high at Habbie's How, into the delightful pastoral valley already mentioned. It continues its course through the whole extent of this valley, which is nearly three miles long, to its further extremity at Castlelaw. The valley is bounded on the north side by Black Hill and Bield Hill; on the eastern extremity by Castlelaw; on the south side by Turnhouse Hill, Caernethy and East Side Black Hill; and its western or upper end, is bounded by the crags and cliffs of Habbie's How. Its bottom is very narrow, not being above the sixth part of a mile broad any where in its course. At the base of Castlelaw, the Logan Water changes its direction, and flows in a varying course, but in general in a south-eastern direction, through the hills to Glencross Bridge, where it escapes from the mountain group into the low and flatter country. That portion of the valley

of the North Esk river, which occurs in this group, extends from Cock Rig, where the sources of the river are situated, to Caerlips Bridge, where the Esk flows into the low country. It is narrow, and is bounded on both sides by green hills of considerable height: these are Caerlips Hill, Mount Hill, and Cock Rig on the one side, and Spittal Hill on the other.

SECTION II.

THE rocks of which this portion of the Pentland Hills is composed, belong to the Transition, Flœtz, and Alluvial classes; no fixed rocks of the Primitive class, as far as I know, having hitherto been discovered in any part of the group. The Flœtz rocks, which are by much the most abundant, form the highest, and sometimes also the lowest parts of the group; whereas the Transition rocks in general occur low down; and both sets of rocks are more or less covered with Alluvial substances.

We shall now describe these rocks in the order of their relative antiquity, beginning with the transition, which are considered as having been deposited before the flœtz and alluvial rocks, and lie deeper in the crust of the earth.

Section III.

TRANSITION ROCKS.

The transition rocks which I have had an opportunity of observing in this group of hills, are Clay-Slate, Grey-Wacke, Greenstone, and I believe also Porphyry.

1. *Clay-Slate.*

The colour of this rock is greenish-grey, or greyish-black; scales of mica are in general intermixed with it, and these give it a glimmering lustre. Its fracture is sometimes fine, sometimes coarse slaty, and in some instances the slaty is associated with a splintery fracture. It is opaque. The streak is grey-coloured. It is soft, inclining to semi-hard; it is easily frangible.

It is distinctly stratified, and the strata run from south-west to north-east, and are nearly vertical.

I did not observe in it either imbedded portions of quartz, or cotemporaneous veins of that mineral; and no felspar, or other imbedded minerals, appear in it. Several of the varieties are nearly allied to Slate-clay, and even appear to pass into it; others again, particularly those ha-

ving a greenish-black colour, appear allied to Compact Slaty-felspar, because, like it, they decay with a white crust, are thick slaty, and harder than the grey-coloured varieties. It sometimes appears more or less curved and waved in its structure,—an appearance not unfrequent in transition clay-slate, and which, like the curved and waved laminæ of more regularly crystallized bodies, is to be viewed as the effect of crystallization.

Hare Hill, as far as I could ascertain, appears to contain much of this rock. It appears also on the north-east and south-west corners of Black Hill, and is frequent in the valley of the North Esk river.

II. *Grey-Wacke.*

The grey-wacke which occurs in our district is very small granular, and has but little of the mechanical aspect of the common varieties of this rock. It is composed of felspar, quartz, and sometimes a little mica; and these minerals are so connected together, as to shew that this rock is a chemical not a mechanical deposite. It occurs in beds varying from a few inches to two or three feet in thickness, and these alternate with the clay-slate already described. I observed it near Habbie's How, and also in the valley of the North Esk river.

III. *Greenstone.*

This rock presents the usual characters of greenstone. It occurs in beds sometimes twelve feet and upwards in thickness, situated in clay-slate. Neither the greenstone nor clay-slate, where in contact with each other, appear altered or intermixed. Two beds of this rock occur in a quarry of clay-slate above Bevelaw-House.

IV. *Porphyry.*

Upon the north-eastern extremity of the Black Hill, where the transition clay-slate occurs, felspar-porphyry and felspar-rock make their appearance and these are so connected with the clay-slate, that I cannot help suspecting portions of these rocks may here belong to the transition series.

Section IV.

FLŒTZ ROCKS.

The flœtz rocks, of which by far the greatest part of this portion of the group is composed, are the following: Conglomerate, Sandstone,

Clinkstone, Clinkstone-Porphyry, Amygdaloidal Clinkstone-Porphyry, Greenstone, Compact Felspar, Claystone, Claystone-Tuff, and Porphyry.

I. *Conglomerate.*

This rock is composed of roundish, angular, and other shaped portions of quartz, grey-wacke, grey-wacke-slate, porphyry, felspar, flinty-slate, common jasper, hornstone, and mica. The portions are from the size of a man's head and upwards, to that of a pea, and the larger masses are connected together by a basis or paste of the smaller pieces, and these again are joined together without any basis, just as stones are which have been deposited from a state of chemical solution. It varies in hardness; two principal varieties may be distinguished, a hard and soft. In the hard variety, the basis and the included portions run into each other, and are so crystalline and firmly joined together, that it is only by means of violence that we can break off masses. This variety generally forms the mass of entire strata; at other times we find it intermixed in cotemporaneous portions in the softer variety. The softer variety is so loose in its texture, that we can readily break it with the hammer, and even extract the imbedded portions with the fingers. It occurs, in general, more abundantly, than the hard variety.

The very small granular varieties of this rock, which are principally composed of felspar and quartz, are very nearly allied to the grey-wacke of this district; indeed, in some instances, it is difficult to distinguish the one from the other in single specimens *.

This fact, in conjunction with one about to be mentioned, namely, That clay-slate occurs in conglomerate, goes to support an opinion I have long entertained, that Transition rocks may alternate with the oldest Flœtz rocks; and, therefore, that the rocks of the transition and the flœtz classes are not separated from each other in the manner generally alleged by mineralogists.

The conglomerate is sometimes very small granular, and earthy in its appearance, and then it is compact, and, both externally and internally, is not unlike certain varieties of basalt and wacke. Varieties of this kind occur at the base of Turnhouse Hill, also at Kirk Hill, and in the lower part of the West March Burn. It is distinctly stratified, and coarse and fine granular strata alternate with each other. The strata are in general inclined at angles from 10° to 30°. Thin layers of a variety of greenish-grey coloured clay-slate occur in it.

* If the Grey-wacke of the Pentlands is a chemical deposite, the same must be the case with the Conglomerate rock described in the text.

It rests upon the transition rocks of the district, and occurs in very considerable abundance. It forms the fundamental rock of Turnhouse Hill, Caernethy, East Side Black Hill, the Kipps, Braid Know, Black Hill, Kirk Hill, Castlelaw, the cliffs at Habbie's How; and nearly the whole of Bald Hill, Mucks Rig, Spittal Hill, and the small hills that extend from West Side to Caerlips, are composed of this conglomerate. On the south-west end of Black Hill, it is associated with porphyry and felspar, apparently in beds; but of this I am not perfectly certain, as the cover of debris prevented me examining the relative situation of the rocks with sufficient accuracy.

II. *Sandstone.*

This rock is generally of a reddish-brown colour, of different degrees of intensity; but some varieties, by the action of the weather, become white or grey. It varies from fine to coarse granular, the latter forming a kind of Sandstone Conglomerate. Its component parts are quartz, felspar, clay, and mica; of these, the quartz is by far the most abundant material. The quartz is of a grey colour, sometimes crystallized, more generally in roundish or angular concretions; the clay is of a reddish-brown colour, and is the substance which colours the sandstone; and the mica oc-

curs in small silver-white scales. I could not discover that these minerals were connected together by any basis; on the contrary, they appear to be associated in the same manner as the felspar, quartz, and mica are in granite. Is it therefore to be considered as a rock deposited from a state of chemical solution? Sandstone, in a general point of view, may be considered as a continuation of the Granite series, and might be denominated *Flœtz Quartz-rock*. It sometimes contains cotemporaneous portions of flœtz-limestone, thus forming a kind of arenaceous limestone-conglomerate. The limestone even appears to form thin and short beds in the sandstone, as is the case in the sandstone rocks above Habbie's How. The limestone is of a grey colour, the fracture is foliated, and it includes cotemporaneous calcareous spar, and variously shaped concretions of compact limestone. Limestones of this kind have been described as brecciated stones, or as composed of fragments: thus, the transition limestones often exhibit this brecciated character, and Brochant, in his valuable paper on Transition Rocks, in the *Journal des Mines* for 1808, maintains, although unsuccessfully, that these limestones are truly brecciated.

Some varieties of the sandstone are not unlike the grey-wacke which occurs near Habbie's How; and consequently closely resemble the fine granular varieties of conglomerate. It is distinctly stratified;

the direction of the strata, south-west and north-east; and the dip varies from 10° to 30°.

It rests upon the conglomerate, as may be observed in the course of the Logan Water above Habbie's How, and appears also to alternate with it, as I infer from the appearances it presents in the conglomerate at the junction of the transition and flœtz rocks, above and a little to the eastward of Bevelaw House.

It skirts the Mid-Lothian portion of the Pentland hills, from the base of the Kirkyetten Hills to the south-west corner of the group, where it rises several hundred feet above the neighbouring country, forming the whole of the East Cairn Hill. It can be traced from the base of the East Cairn Hill, down the course of the Logan Water, to within a few yards of the waterfall at Habbie's How, and it appears to cover a considerable portion of the high muirish flat traversed by the Logan Water.

III. *Clinkstone, Clinkstone-Porphyry, and Amygdaloidal Clinkstone-Porphyry.*

The clinkstone, when pure, is of a deep greenish-grey colour; but when iron-shot, which is generally the case, it is reddish-brown: the lustre of the principal fracture is glistening, of the cross fracture glimmering: the principal fracture is

slaty, the cross fracture uneven, passing into imperfect and small conchoidal. It is translucent on the edges, hard, brittle, rather easily frangible, and rather heavy.

It is nearly allied to felspar, and is to be observed passing into the compact felspar, which occurs so frequently in the Mid-Lothian portion of the Pentland Hills; it also sometimes inclines to claystone, and in other instances nearly passes into basalt: The darker-coloured varieties, those inclining to basalt, sometimes contain imbedded cotemporaneous portions of quartz, nearly an inch square: and the iron-shot varieties, are sometimes traversed by cotemporaneous veins of lamellar heavy-spar. Crystals of felspar occur frequently imbedded in it, and then it forms *clinkstone-porphyry*, or what is sometimes called Porphyry-slate. The crystals of felspar are sometimes of considerable size, and in certain varieties of this rock, are remarkable for their breadth and thinness. Sometimes the clinkstone-porphyry passes into a kind of felspar-porphyry, as on the west side of Glencross. Sometimes the amygdaloidal porphyry is intermixed with green-coloured sandstone, or the sandstone appears imbedded in the porphyry in the form of fragments: in other instances, we observe the sandstone, which appears to occur in small beds in the porphyry, including what at first sight appear to be fragments of porphyry. This mutual intermixture of the sandstone and porphyry, the gradual passage of the inclosed sandstone into the

porphyry, and of the porphyry imbedded in the sandstone, are proofs, not only of the cotemporaneous formation of these two rocks, but also of the chemical nature of the sandstone. This porphyry is often amygdaloidal, and then it is named *amygdaloidal clinkstone-porphyry* *. The amygdaloidal cavities are more or less completely filled with mineral substances of different kinds: sometimes they are entirely filled with green-earth, or the green-earth merely encrusts the vesicular cavities, and the cavity is filled up with agate. The agate is associated with amethyst, and also with common calcedony, which latter is sometimes stalactitic, and is so circumstanced, as to shew, that although stalactitic in form, it is not so in formation, being rather a crystalline shoot, than a stalactitic deposition. Sometimes the vesicular cavities are filled with a mixture of calcareous-spar, heavy-spar, and brown-spar. The agates and calcedonies are of considerable magnitude, some specimens being several inches square. Some varieties of the rock contain diallage. The porphyritic clinkstone is sometimes tufaceous, as in Glencross, and at first sight

* Some of these varieties are grooved very deeply. These groovings are seen sometimes on the surface of masses, sometimes in their interior, and we observe in this latter case that the grooves fit into each other: I have noticed the bottoms of the beds somewhat convoluted.

appears to be composed of rolled masses of porphyry or clinkstone, contained in a porphyritic basis; but these masses are to be observed passing by imperceptible degrees into the basis, and hence are of cotemporaneous formation with it, and cannot be viewed as fragments.

This rock rests upon the conglomerate; but its immediate relation to the red sandstone, I had no opportunity of ascertaining. It occurs very abundantly throughout the Mid-Lothian part of the Pentlands, but more frequently in the middle part, and the eastern extremity, than in the western. It appears in general rather on a low level, near the foot of the hills; although in particular instances, as at the Kipps and the Kirkyetten Hills, it forms summits upwards of a thousand feet high.

On the outside of the group, it extends from East Side to Kirkyetten, and onwards to Malleny, forming a nearly continuous mass. The smaller hills that skirt the group in this line of direction, are also composed of it; and it is to be seen in the interior of the group in the Logan Water valley, at the foot of Turnhouse, Caernethy, and Castle-law Hills, where it rests upon conglomerate; and fine sections of it are exposed on both sides of Glencross.

IV. *Greenstone.*

This is not a frequent rock in the flœtz series of the Pentlands. It is in general small granular, and appears to pass into basalt, and sometimes to form that variety of rock named Basaltic Greenstone. It is at times amygdaloidal, and then it contains calcareous spar and agate. It occurs above the conglomerate at the north-east corner of Turnhouse Hill, and at the base of Black Hill, about a quarter of a mile from Habbie's How. Many rolled masses of a large granular greenstone, along with basalt and amygdaloid, occur in the bottom of the West March Burn, but I did not find any of these rocks *in situ* any where in the course of the rivulet.

This rock appears to be associated with the clinkstone, and probably occurs in beds below, or in it.

V. *Compact Felspar.*

The colour of this rock, is flesh-red, or brownish-red; sometimes greyish and yellowish-white, and ash-grey and yellowish-grey. It is massive. The lustre is glimmering, and the fracture minute foliated, and splintery, and sometimes conchoidal, sometimes slaty. It is semi-hard and brittle. Specific gravity 2,497 *. Some varieties of the felspar exhi-

* Vid. Mackenzie on Compact Felspar. "Memoirs of the Wernerian Society," vol. i. p. 617.

bit a very deep-grooved surface: this is strikingly the case with the felspar of Braid Know. It is sometimes porphyritic, and then it contains imbedded crystals or grains of felspar; sometimes also scales of mica, crystals of augite, and of common quartz, or of rock-crystal. A remarkable variety of this mineral occurs near Habbie's How and other parts of the group, in which beautiful globular concretions of light red-coloured felspar are imbedded in dark-red felspar. These concretions are from one-sixth of an inch, to an inch in diameter. Other globular concretions occur in the felspar; these are composed of concentric lamellar layers of red felspar, and of a green-coloured substance, which is probably very minute granular hornblende, either pure or intermixed with felspar. Both these kinds of concretions are evidently of cotemporaneous formation with the felspar in which they are contained, because they are principally composed of that substance, and exhibit no marks of attrition; on the contrary, are to be observed gradually passing into the surrounding mass. Compact felspar is observed passing, on the one hand, into hornstone, and on the other into claystone. It occurs in beds, and in cotemporaneous masses several feet square in conglomerate, at Habbie's How; and at the same place, it appears to rest on transition clay-slate.

It occurs abundantly in Black Hill, Bield Hill, Kirk Hill, Capelaw, and Castlelaw, where it is more or less frequently associated with claystone. It also occurs, but less frequently and abundantly,

in the Kirkyetten Hills, Turnhouse Hill, Caernethy, East Side Black Hill, and Braid Know.

VI. *Claystone.*

The principal colours of this mineral, are grey, blue and red; and it frequently exhibits dendritic delineations. Its fracture is earthy and dull. It is opaque; soft; rather brittle. Rather easily frangible. Feels meagre and rough. Does not adhere to the tongue. Rather heavy.

It is stratified. It passes into compact felspar. Sometimes portions of the claystone appear harder than the usual varieties, and these are passing into compact felspar: when they are imbedded in the common earthy claystone, the mass appears as if conglomerated or brecciated, and this appearance is rendered more evident when the basis is of a different colour from the harder portions. These harder portions vary in shape and size, being sometimes angular, sometimes more or less rounded, and from the size of a pea to that of a man's head and upwards. Appearances of this kind have been considered as proofs of the mechanical nature of the mass; but the circumstance of these imbedded portions passing imperceptibly into the surrounding mass, and of the uninterrupted transition, from the distinctly formed concretion, to the mere tendency to this form, joined to the occurrence of this harder claystone in cotemporaneous veins in the mass, prove

that it is entirely of a chemical nature. Sometimes it has still more of the fragmented appearance, when it forms *claystone-tuff*, a rock to be described afterwards. It rests upon claystone-tuff; is frequently intermixed with it, and probably alternates with it. It passes into *porphyry*, a rock which rests upon it; and is intimately related to compact felspar, into which it passes, and in which it is probably contained in beds.

On the north-east, south, and south-west acclivities of Turnhouse Hill, where the line of junction can be discerned, it is to be observed resting upon claystone-tuff, and as far as I could ascertain, never below or alternating with the clinkstone-porphyry. In this hill, its line of junction with the clinkstone varies much in height: in some instances, as on the eastern, and north-eastern foot of the hill, being almost washed by the Logan Water; but more frequently it is far above the level of the river, several hundred feet above the bottom of the valley. It occupies nearly the same general high level in Caernethy and East Side Black Hill; and on the north side of East Side Black Hill, I saw it resting on claystone-tuff, which appears to rest on clinkstone-porphyry. From East Side Black Hill, along the western or upper end of the valley of Logan Water, it does not appear until we pass Logan Water, when numerous fragments of it are to be observed on the west side of the valley, leading from Habbie's How north-east towards Bevelaw, where it appears to be associated with com-

pact felspar. From this valley, it may be traced more or less uninterruptedly along Black Hill, Kirk Hill, and Castlelaw, and onwards to the Kirkyetten Hills, where it forms a considerable portion of the striking rocky face named Kirkyetten Craig. In the whole of this course, it is associated with compact felspar.

VII. *Claystone-Tuff.*

This rock is composed of claystone, in which are included apparent fragments, of various sizes and shapes, of claystone, porphyritic-claystone, conchoidal-hornstone, porphyritic-hornstone, compact felspar, and red flint. It is sometimes traversed by veins of conchoidal-hornstone and porphyry; and these, as well as all the different kinds of fragments, are of cotemporaneous formation with the claystone basis *. The conchoidal-hornstone sometimes assumes a slaty appearance, and passes into striped jasper: it also passes into claystone, compact felspar, and into flint. Both the claystone and the conchoidal-hornstone are sometimes beautifully dendritic.

It appears in some instances to rest on conglomerate, sometimes on clinkstone-porphyry, and is

* It is evident that the formation of trap-tuff must also be chemical.

frequently covered with claystone. The finer granular varieties, gradually pass into claystone; and probably it is contained in great cotemporaneous portions in the claystone, or alternates in beds with it.

It occurs in Turnhouse Hill, Caernethy, East Side Black Hill, Kirk Hill, Castlelaw, and the Kirkyetten Hills, and in general it is situated on a higher level than the clinkstone.

VIII. *Porphyry.*

The basis of this rock varies in colour from grey, through blue to red. The fracture is earthy and dull. It is opaque, soft, sectile, rather easily frangible, and rather heavy; so that it appears to be nearly of the same nature as claystone. It contains imbedded crystals of felspar, which are generally small, almost always in a soft or disintegrated state, and in the bluish varieties nearly in the state of steatite. It passes on the one hand into claystone and compact felspar, and on the other it inclines to basalt and clinkstone.

It rests on claystone, and is frequently intermixed with it. It forms the higher parts of Turnhouse Hill, Caernethy, East Side Black Hill, Castlelaw, and occurs also in Kirk Hill, Black Hill, and amongst the Kirkyetten Hills.

SECTION III.

ALLUVIAL ROCKS.

The alluvial substances are few in number, of little extent, and do not present great variety in appearance: they are, Rolled Masses, Gravel, Clay, and Peat.

I. *Rolled Masses.*

These are generally portions of the neighbouring rocks, which have been broken off by the influence of the weather, and rolled in the water of the rivers and rivulets of the district. Amongst these, however, I observed several large masses of what may be named *primitive grey-wacke*, and which is foreign to this part of the country; its nearest native place being near Dunkeld in Perthshire. Similar masses occur in different parts of Mid-Lothian; also in Fifeshire. How have they been transported to their present situation?

II. *Gravel, Sand, and Clay.*

The gravel, sand, and clay, are portions of the rocks of the district, more or less completely bro-

ken down, and intermixed together. They are spread over the bottom of the valleys, and sides of the hills; but not in equal quantity, for the gravel and sand are more abundant than the clay.

III. *Peat.*

This well known substance, occurs in considerable abundance in different parts of the district, but does not present any peculiar appearance.

I hope, on a future occasion, to be able to extend my inquiries to the western portion of the Pentlands, and to accompany the description of that part of the group with a map of the whole range, and a more particular description than that which I now lay before the Society, of the Mid-Lothian division.

XIV. *On Conglomerated or Brecciated Rocks.*

By Professor Jameson.

(*Read 4th December* 1813.)

All the rocks included under this general head, are supposed by mineralogists to be *mechanical* deposites, and are said to be composed of fragments of different kinds, more or less intimately joined together by means of a ground or basis. It is the object of the present paper to point out the mineralogical relations of these rocks, and to shew that certain varieties of them are *chemical*, not mechanical, deposites.

Section I.

Mineralogical relations of conglomerated or brecciated rocks.

Conglomerated rocks occur in Primitive, Transition, and Flœtz country.

I. Primitive Conglomerated Rocks.

The primitive conglomerated rocks occur in beds or strata of considerable magnitude, in Gneiss, Mica-Slate, Granite, Porphyry, and Limestone.

1. *Conglomerated Gneiss.*

The gneiss conglomerate, is formed of roundish and angular fragments, or portions of gneiss, hornblende-rock, felspar, and quartz, connected together by a ground or basis of gneiss. Sometimes the whole bed has the conglomerated character; in other instances, only a part of it is in this state; the other portion, and frequently the largest, being of pure gneiss. This rock occurs near the Castletown of Braemar in Aberdeenshire, at Valorsine and St Bernard in Switzerland, and also amongst the mountains of Norway, as appears from the following description by Von Buch: "The interior of the rocks is here not less remarkable. At first, the quartz continues from Formo onward. It then frequently resembles porphyry; for there are imbedded in the grey-coloured quartzy basis, dark crystals of quartz, and the rock is almost every where intersected by *drusy* fissures. At length, about half a German mile from Formo, the gneiss also makes its appearance in the valley, and the quartz rocks disappear. The gneiss rises immediately to a great thickness. The Rosten-

berg commences immediately after its appearance, as well as the ravine towards Lessöe; and in these straits, it becomes very remarkable. It generally abounds in mica; the mica is not scaly-foliated, but in considerable folia, which are continuous, and it abounds with beds of quartz. But there is also every where considerable pieces of gneiss dispersed through it, in which the felspar predominates; the mica only appears in separate isolated folia, and the quartz very sparingly. The mica in these pieces, forms more straight and parallel running streaks, than slate; while, on the other hand, the slaty composition in the surrounding gneiss is more strongly marked and distinct. These pieces are all angular, and most of them even are quadrangular; of so considerable a magnitude, as a foot and upwards, and they appear, in fact, very thickly heaped together; but still in such a manner, that we always distinguish the connecting gneiss mass or ground. The streaks of the different pieces lying near each other, are often parallel, but they also frequently take completely different directions. They do not consequently follow the direction of the slaty structure of the gneiss which constitutes the basis. This wonderful rock is not a conglomerate, the pieces being too small. The basis is too distinct, and too strongly characterised as gneiss. But it must be owned, that this appearance bears some resemblance to the manner in which the puddingstone is found in gneiss at Valorsine, and in the lower Vallaïs, according

to Saussure :—an older gneiss which was destroyed in the period of the formation of the newer *."

2. *Conglomerated Mica-Slate.*

The second kind of conglomerated primitive rock, is that which occurs in mica-slate. It is composed of variously-shaped portions of quartz and sometimes of mica-slate, imbedded in a basis of mica-slate. It occurs in the country between Dunkeld and Mullenæarn in Perthshire; and many years ago I saw a variety of this rock in Fetlar, one of the Zetland Islands, as mentioned in the second volume of my "Mineralogical Travels."

3. *Conglomerated Granite.*

This rock occurs principally in the newer granite formations. It is composed of portions of granite, gneiss, mica-slate, quartz, and felspar, imbedded in a basis of granite. This granite rests upon clay-slate or other older primitive rocks. It occurs in Saxony and other countries on the Continent; and a conglomerated granite, although probably of a different formation from the Saxon, occurs in the Grampians.

* Von Buch's "Travels in Norway and Lapland." Black's translation, p. 94. and 95.

4. *Conglomerated Rock associated with Porphyry.*

This rock is composed of portions or fragments of granite, gneiss, mica-slate, clay-slate, &c. imbedded in a basis of clay-slate. It lies below what is termed the Overlying Primitive Porphyry, and over clay-slate and other older primitive rocks. It occurs in Saxony and other countries in Germany; also in Upper Egypt.

5. *Conglomerated Limestone.*

This is the rock known to mineralogists under the name *verd-antique.* It is composed of limestone and serpentine, indeterminately aggregated together, and so intermixed as sometimes to present a conglomerated aspect.

These are the principal primitive conglomerated rocks I have had an opportunity of examining.

II. TRANSITION CONGLOMERATED ROCKS.

These are, Grey-Wacke, Sandstone, and Limestone.

1. *Grey-Wacke.*

This rock is composed of pieces of clay-slate, grey-wacke, flinty-slate, felspar, and quartz, imbedded in a basis of the same materials, or a basis of clay-slate. The pieces or apparent fragments vary in magnitude, from that of a pea, to much above that of a man's head. It is distinctly stratified, and alternates with clay-slate, limestone, and other rocks. It abounds in the alpine country, to the north and south of the Firth of Forth.

2. *Sandstone.*

This rock is composed of grains of quartz, seldom exceeding a pea in size, connected together without any basis, just as quartz concretions are in mica-slate and quartz rocks.

3. *Limestone.*

Conglomerated limestone rocks are not uncommon in transition country. They at first sight appear to be composed of fragments of limestone, imbedded in a limestone basis or ground. Sometimes portions of compact limestone appear imbedded in granular limestone; in other instances, portions

of granular limestone appear imbedded in compact limestone.

III. Flœtz Conglomerated Rocks.

The conglomerated rocks of the flœtz class, are, Sandstone-Conglomerate, Sandstone, and Trap-Tuff.

1. *Sandstone Conglomerate.*

This rock is composed of rounded and angular pieces of granite, gneiss, mica-slate, clay-slate, porphyry, grey-wacke, felspar, jasper, quartz, &c. varying in size from that of a pea, to much above that of a man's head. These fragments are connected together by means of a basis composed either of iron-shot clay, quartz, or of smaller fragments of the same nature as the larger.

It usually occurs resting upon transition rocks, sometimes also lying on primitive rocks. It is a frequent rock in this country.

2. *Sandstone.*

This rock is principally composed of quartz, which is either in roundish or angular grains, or more or less regularly crystallized: it is seldom pure, more generally it is intermixed with scales

of mica, roundish grains or crystals of felspar, and apparent fragments of different kinds: and all of them are connected together either by means of a clayey, calcareous, or quartzy basis, or are immediately joined together without any cement or basis, as is the case in granite. It is a very frequent and abundant rock, and occurs in the form of strata, beds, and veins, along with limestone, gypsum, slate-clay, coal, and other minerals.

3. *Trap-Tuff.*

Trap-tuff is composed of masses of basalt, amygdaloid, greenstone, wacke, felspar, clinkstone, trap-tuff, limestone, sandstone, brown-coal, &c. immersed in a basis of trap, which is sometimes of the nature of basalt, sometimes of the nature of wacke. It is associated with flœtz-trap rocks, and is very frequent and abundant in the middle division of Scotland.

Section II.

THE MODE OF FORMATION OF CONGLOMERATED OR BRECCIATED ROCKS.

Let us now enquire whether these conglomerated rocks are Chemical or Mechanical formations.

In all true conglomerated rocks, the fragments of which they are composed, are either water-worn, or present distinct fractured surfaces; they are not intermixed at their edges with the basis in which they are contained; we do not observe the substance of the fragment gradually passing into that of the basis, and we never see the basis by a series of gradations assuming the form of fragments. Such appearances, however, occur in rocks having a conglomerated aspect, but which appear to have been deposited from a state of chemical solution. These characters, therefore, when taken in conjunction with other geognostic relations, afford us the means of distinguishing true conglomerated rocks from such as are probably only so in appearance.

The following short examination of the particular characters exhibited by certain conglomerated rocks, will afford us proofs of the plausibility of the opinion just stated, viz. that many conglomerated rocks are chemical deposites.

In the conglomerated gneiss, mica-slate, and granite, the imbedded masses are only apparent, not true fragments; for, upon examining them, we do not find either water-worn or fractured surfaces; on the contrary, they are intimately mixed with the basis at their junction with it; and they are observed passing into it in so gradual and imperceptible a manner, that we cannot say where the one begins and the other terminates. The same is the case with the conglomerated rock which ac-

companies primitive porphyry, and with the verd antique or brecciated primitive limestone. Hence these rocks are to be viewed as chemical deposites, and as they are the only primitive rocks exhibiting the fragmented aspect, we are entitled to infer, that, as far as we know at present, true conglomerates do not occur in primitive country.

Grey-wacke, the next conglomerated rock we described, has been hitherto considered as a mechanical deposite. But the fragments in this, as in the rocks already described, are to be observed gradually passing into the surrounding mass, and intermixed with it at their line of junction, and apparent fragments of grey-wacke-slate, several feet in length and breadth, and not more than one-twelfth of an inch in thickness, which must have been broken into pieces, had they been true fragments, are imbedded in the grey-wacke. Further, the constituent parts of the rock are frequently connected together without any basis, in the same manner as the felspar, quartz, and mica in granite; and we also observe the ingredients concentrating in the basis into roundish and other shaped distinct concretions. These facts go to support the opinion, that grey-wacke is a chemical not a mechanical deposite.

In the conglomerated transition limestone, which has excited so much attention amongst mineralogists, the fragments have the same characters as those in grey-wacke, conglomerated gneiss, &c., and are therefore to be considered of cotempo-

raneous formation with the limestone in which they are contained, and consequently, the whole mass is to be viewed as a chemical formation.

The sandstone-conglomerate has much more of the mechanical aspect than any of the rocks we have at present described. Indeed, its general appearance is so much that of a mechanical deposite, that I long hesitated as to its true nature, and it was only after minute and careful investigation I was induced to believe, that some varieties at least of this rock are of a chemical nature. This opinion, I started in my sketch of the Mineralogy of the Pentlands, read before the Society some time ago, and still find no reason to alter it. One of the best examples of the chemical sandstone-conglomerate in this neighbourhood, is that at Habbie's How in the Pentlands. This conglomerate, as is mentioned in my description of the Pentland Hills, is composed of variously-shaped masses of grey-wacke, grey-wacke-slate, flinty-slate, felspar, jasper, and quartz, immersed in a basis composed of smaller fragments, generally of the same minerals as the larger. The most abundant of these apparent fragments, are those of grey-wacke, which have generally a globular or oval form, and vary in size, from a walnut to that of a man's head and upwards. They are composed of felspar, quartz, and a little mica, which are connected together without any basis, or have the same mode of aggregation as that observed in crystalline rocks, such

as granite and syenite. The basis in which these apparent fragments are contained, is of the same nature with the fragments themselves, and it therefore is also of a crystalline nature. But it may be said, that these apparent fragments are in reality true fragments imbedded in a crystallized basis; but this cannot be the case, because they do not exhibit water-worn or fractured surfaces, and are to be observed passing by imperceptible degrees into the substance of the basis in which they are immersed. A further proof of the truth of the opinion now stated, is afforded by the appearance which the basis itself at times assumes. Thus, we sometimes observe the ingredients of the basis concentrating into indistinct globular masses, which are harder than the general basis; and, in other instances, the concentration of the parts, is still more distinct, and the globular concretions thus formed, are so strongly marked, as not to be distinguishable from the large apparent fragments.

Sandstone, another of the conglomerated rocks we described, is in general supposed to be sand agglutinated by means of a clayey, calcareous, or quartzy basis, and hence it is said that all sandstones are mechanical deposites. This opinion, I suspect, is not correct, because appearances in several of the sandstones of this country, seem to intimate, that these, at least, are more of a chemical than of a mechanical nature. These sandstones, when examined with the glass, appear to

be composed sometimes of crystallized quartz, connected together without a basis, sometimes of quartz in angular or roundish concretions also joined together without a basis. The quartz is sometimes intermixed with concretions or crystals of felspar, and these appear imbedded in the quartz in the same manner as grains and crystals of felspar are in porphyry or granite; and mica occurs in these rocks in the same mineralogical relations. These sandstones, then, do not differ from granite or porphyry in structure, and therefore are to be considered, like them, as chemical formations, or as having been deposited from a state of chemical solution. Other sandstones are entirely composed of quartz in granular distinct concretions, and these are sometimes so pure, that they might in single hand-specimens be confounded with primitive granular quartz. If, then, primitive granular quartz be a chemical deposite, of which there cannot be a doubt, certainly this sandstone must also have been deposited from a state of chemical solution. But this beautiful and highly crystalline quartzy sandstone alternates in beds with that variety of sandstone which resembles the common building sandstone of this vicinity; it even occurs in the same stratum or bed with it, and there is an uninterrupted transition from the one into the other; if, therefore, the quartzy sandstone be a chemical deposite, the same must be the case with the common building sandstone. The occurrence of a clayey or marly basis

in the sandstone, does not affect the plausibility of the opinion here stated. Sandstone sometimes occurs in globular and concentric lamellar concretions, and in cotemporaneous veins, in sandstone and trap rocks; also in kidneys, in slate-clay, amygdaloid, and other rocks, appearances expressive of the crystalline nature of the sandstone, because they occur only in granite, greenstone, and other crystalline rocks. If, then, the opinion just stated in a very general way, shall prove correct, it will afford us an easy explanation of all the varieties of curvature, hardness, and position, observed in sandstone strata; and the alternation of sandstone with limestone, trap, and other rocks, will no longer be difficult of explanation.

Trap-tuff, the last conglomerated rock we enumerated and described, is generally supposed to be entirely a mechanical deposite; but I am inclined to view it more as a chemical than a mechanical formation. This opinion, I stated in my account of the Pentland Hills; and the following are some of the facts that still induce me to consider it as the most plausible explanation of the mode of formation of that rock.

1. The masses of basalt, amygdaloid, felspar, and of other trap rocks contained in the tuff, are to be observed gradually passing into the trap basis in which they are contained.

2. Cotemporaneous veins of basalt and amygdaloid traverse the tuff*.

3. The tuff itself sometimes occurs in globular concretions, and these concretions are again composed of curved lamellar concretions.

4. Some varieties of tuff, like basalt and greenstone, are entirely composed of globular distinct concretions.

5. Cotemporaneous veins of tuff traverse it in all directions.

6. Cotemporaneous veins, partly of the nature of tuff, partly of the nature of basalt, occur in the tuff.

7. The masses of basalt and other rocks in the tuff, are sometimes of such an enormous size, and so constructed of easily separable concretions, as to banish every idea of their being rolled fragments.

8. Lastly, The quantity of mechanical intermixture, is in general inconsiderable, and it is principally composed of fragments of primitive, transition, and older flœtz rocks.

From the preceding descriptions and observations, it follows, that the quantity of mechanical mineral matter in the crust of the earth, is far less considerable than has been generally supposed.

* These veins agree in so many characters with the veins of basalt, porphyry, granite, pitchstone, &c. usually considered of after-formation, that I am inclined to view many of these also as of a cotemporaneous nature.

XV. *On Porphyry.*

By Professor Jameson.

(*Read 14th December* 1811.)

According to Werner, there are five different kinds of porphyry, viz. clay-porphyry, hornstone-porphyry, pitchstone-porphyry, obsidian-porphyry, and pearlstone-porphyry; all of which occur in Primitive country, and either in a conformable or unconformable and overlying position *. He does not enumerate in his system of rocks any Transition porphyry; and in the Flœtz class, the only rock that can be considered as appertaining to this species, according to the Wernerian view, is his Porphyritic-stone, or Porphyritic claystone.

* I may here remark, that it is not improbable that some porphyries described as overlying, are not so in reality, being merely conformable beds cut into variously-shaped masses by the action of the weather; and these, when viewed in particular directions, appear to be uncomformable and overlying.

In the third volume of my System of Mineralogy, and in my Mineralogical Travels, I have shewn, that several of Werner's Primitive porphyries, occur in this country, and shall now prove, that we also possess Transition and Flœtz porphyries.

The *transition porphyries* have either a claystone or felspar basis, and, besides crystals of felspar, they sometimes also contain grains and crystals of quartz, scales of mica, and crystals of hornblende. They occur in beds which are from two to twelve or fifteen feet in thickness, of great extent, and alternate with grey-wacke and transition clay-slate. I first noticed these rocks in the year 1804, during my examination of the county of Dumfries, but hesitated introducing them into the system as porphyries, until I should have an opportunity of examining them more particularly, and in other parts of Scotland where I might find them still on a greater scale, and more distinctly characterized. Last summer, during my stay in Dumfriesshire and Galloway, I paid particular attention to these rocks, and convinced myself that they are true Porphyries, and belong to the Transition class.

In the tract of mountainous country which extends from Langholm by Eskdalemuir and Whamphry, the district where I first noticed these porphyries, the beds are but a few feet thick, and cannot be traced far owing to the cover of soil and grass. They are contained in grey-wacke. In the mining

district of Leadhills, which is situated in transition rocks, I observed several beds of felspar, and some of claystone-porphyry. In the great tract of transition country which extends from New Galloway to Dumfries, there are beds of transition porphyry that alternate with grey-wacke, grey-wacke-slate, and transition greenstone. At Fasshey Burn in East-Lothian, transition porphyry is associated with transition granite and syenite. These porphyries also occur in the transition rocks that occur so abundantly to the north of the Frith of Forth.

The *flœtz-porphyries*, like those of the transition class, have a basis of felspar, or of claystone; and contain, besides crystals of common felspar, also crystals of glassy felspar and of common quartz, sometimes almost passing into rock-crystal. They occur in beds, often of great magnitude, that alternate with the first or old red sandstone, or in vast mountain masses resting on that rock. They sometimes also appear in veins of great width, seventy feet and upwards, and of great extent, that traverse this sandstone.

Flœtz clay-porphyry occurs abundantly in the Island of Arran, in the form of mountain masses, beds, and veins, connected with the old red sandstone of that island. Flœtz felspar-porphyry occurs resting upon sandstone, in the islands of Raasay and Skye, and in the Ochil and Pentland Hills. Flœtz pitchstone-porphyry, and flœtz pitchstone occur in beds alternating with clay-porphy-

ry and red sandstone in the island of Arran, and frequently in the form of veins traversing the sandstone.

I have given an account of the occurrence of porphyry in flœtz country, in my Description of the Island of Arran, published in the year 1798, and in my Mineralogical Travels published in the year 1800. In my System of Geognosy, published in the year 1808, I do not introduce the Flœtz Porphyries into the Wernerian arrangement of rocks there explained, because I was not then convinced of the accuracy of my early observations. Having again visited Arran, and re-examined the appearances described in my early writings, I find that they are correct; and, therefore, do not now hesitate to consider Porphyry as a member of the Flœtz class.

XVI. *Mineralogical Observations and Speculations.*

By Professor JAMESON.

(Read 8th January 1814.*)*

I. *On Stratification.*

THE matter of which the solid part of the Earth is composed, is of a metallic nature, and is more or less oxidized. During its formation, oxidation, and combination, great degrees of cold, and also intense degrees of heat, were probably induced, and these latter may have occasioned fusions, &c., somewhat resembling those caused by volcanoes. This matter appears to have been formed in a determinate and regular order, in the form of tabular masses or strata, which are to be considered as bearing the same relation to the Earth, as the folia of crystals do to the crystals in which they occur. These strata are not irregularly disposed: on the contrary, it is highly probable that they are so arranged, that when viewed in the great scale

they will be found to meet under determinate angles, just as folia do in crystals *.

The strata, according to this view, are to be considered as the *cleavage* of the earth; and consequently their formation must have been more simultaneous than is generally supposed. The prevailing opinion in regard to the formation of strata, is, that each stratum is a separate deposite; that the strata are distinctly separated from each other by what are termed the Seams of Stratification; and that cotemporaneous veins never pass from one stratum into another. But the following considerations induce me to call in question the accuracy of this opinion, and incline me rather to believe in the more simultaneous formation of strata.

1. The seams of the strata, or those lines which are said in all cases to mark the boundaries of a stratum, do not always continue throughout the whole mountain range; on the contrary, we sometimes find seams of several strata terminating in the substance of a larger stratum, and these again in the substance of a still larger stratum, in this way exhibiting nearly the same characters as those observed in the seams of the distinct concretions of crystalline rocks of the trap and por-

* As the true figure of the earth is still unascertained, may we not conjecture from what is already known, that it is a polyedron, and that the strata under determinate angles form the sides and cleavage of this great crystal?

phyry series. But these strata-seams are almost always parallel with the slaty structure of the rock, so that, when they disappear in slaty rocks, the direction and dip of the rock may be ascertained by attending to the position of the slaty structure. It would appear from this statement, that the seams of the strata are in many cases to be viewed as particular separations effected in the crystallizing substance, of the same nature, but on a larger scale, than the seams in the distinct concretions, or the laminæ of the slaty structure *.

2. In primitive country, an uninterrupted transition is to be observed from granite to clay-slate, in such a manner that the great masses are to be considered as principal formations, and the smaller as subordinate formations; and these are so connected by intermixture and gradations, that we can say of any two contiguous portions of rock, whether separated by strata-seams or not, that they are of cotemporaneous formation; thus, any two contiguous portions of granite, of gneiss, or of gneiss and granite, or of gneiss and mica-slate, are of cotemporaneous formation.

* In horizontal strata of sandstone and other rocks, we sometimes observe the slaty structure at right angles to the direction of the stratum: if, then, the slaty structure, and the strata-seams are but varieties of the same character, it follows, that vertical strata have not been in general elevated into their present situation by a force acting after their formation, but are in their original position.

3. Cotemporaneous veins, which in every theory are supposed to have been formed at the same time with the rock in which they are contained, are to be observed passing through several different strata or beds, as through granite and gneiss, or through basalt, amygdaloid, wacke, and trap-tuff, thus proving that these strata or beds are of simultaneous formation, or that no cessation of the process of deposition took place after the formation of each of the individual rocks.

4. Beds of mountain rocks, as of granite in gneiss, are so connected with the surrounding strata, that we cannot hesitate in considering them as illustrative of the simultaneous formation of strata in general. Thus, these beds are sometimes of considerable extent, and terminate in every direction in the rock in which they are situated, and are so intermixed at their meeting or line of junction that it is difficult to say where the one begins and the other ends. Here, it is evident, that the granite of the lowest part of the bed is of cotemporaneous formation with the immediately subjacent gneiss; that the granite of the uppermost part of the bed is of cotemporaneous formation with the gneiss immediately above it; and that the granite of the great portion of the bed has been formed at the same time with the bounding gneiss. In other instances, these beds are of great thickness, and send out from them veins of granite in all directions into the surrounding rock.

5. Certain appearances in trap rocks are illustrative of the simultaneous formation of strata. In these rocks, we sometimes observe small imbedded portions of limestone and slate-clay, so intermixed with trap, as to prove their cotemporaneous origin with it; in other instances, the limestone and slate-clay appear in the form of small layers, alternating with each other, and fairly included in the trap: and I have observed in some districts, beds of limestone, slate-clay, and clay-ironstone, alternating with each other, and of considerable extent; and all of them fairly included in an immense bed of trap. The quartzy sandstone which so often accompanies trap rocks, presents similar appearances with the limestone, &c. just mentioned. Other formations, as I shall particularly explain in a future communication to the Society, present the same remarkable appearance of series of strata being contained in one great stratum or bed, or in a series of strata of one species of rock. In the cases just stated, trap, limestone, slate-clay, and clay-ironstone strata, have been formed at the same time; but the limestone, slate-clay, and clay-ironstone, being included in the trap, bear the same relation to it, that crystals of quartz do to the basis in which they are imbedded, or cotemporaneous portions of gneiss to the granite in which they are contained.

II. *On Veins.*

Two opinions prevail at present in regard to the formation of veins: According to the one, nearly all veins have been formerly open rents, which have been filled from above with the mineral substances they now contain; according to the other, these rents have been filled from below by the agency of subterranean heat. The latter opinion, I have always considered as untenable; and the former, although the most plausible, has, I suspect, been too much generalized. I am now inclined to believe, that many veins said to have been filled from above, are of cotemporaneous formation with the rocks in which they are contained, and may have been in many instances formed by the mere shooting or crystallizing of the venigenous matter across the direction of the strata, and therefore do not owe their origin to any previously existing rent. This opinion is illustrated by the following facts and observations:

1. In the kidneys of granite in gneiss, admitted in every theory to be of cotemporaneous formation with the rock in which they are contained, we observe the granite shooting from the kidney in the form of veins into the bounding rock. This, then, is an example of the formation of veins without previously existing fissures or rents.

2. Veins that issue from larger masses of granite, and cut across strata of gneiss, grey-wacke, or other rocks, are of the same nature, *i. e.* are veins formed without previously existing rents*, because these masses are kidneys on the great scale.

3. Beds of limestone sometimes alternate with beds of trap, and consequently they are to be considered as of cotemporaneous formation. These beds of limestone sometimes send off branches or veins into the surrounding trap; consequently these veins are to be considered as of cotemporaneous formation with the limestone, and therefore may have been formed without any previously existing rent..

4. Beds of porphyry, sienite, greenstone, &c. which terminate in the surrounding strata, sometimes, during part of their course, cross the direction of the strata of the rocks in which they are contained, and thus acquire the character of veins: but these beds are of cotemporaneous formation with the bounding rocks; hence this fact may be viewed as illustrative of the formation of veins without previously existing rents, and also of the cotemporaneous formation of porphyry, greenstone, and other veins.

* These masses have been sometimes viewed as fragments; but that idea is inconsistent with their geognostic relations, and particularly their magnitude, for there are well ascertained instances of their extending for miles.

5. In mica-slate, also in clay-slate, we observe cotemporaneous kidneys of quartz, from a few inches to many fathoms in extent: frequently these masses have an elongated form, and at length, by a series of gradations, become tabular; in which form, they are to be considered as cotemporaneous veins, formed without any previously existing fissure. Similar appearances occur in trap rocks, where cotemporaneous kidneys and veins of greenstone occur in greenstone; and cotemporaneous kidneys and veins of basalt occur in trap-tuff.

6. In some veins, even in those of a metalliferous nature, the seams of the strata are not interrupted by the vein, but fairly cross it. This fact is also in support of the opinion of the formation of cotemporaneous veins without any previously existing rent.

7. Cotemporaneous veins frequently cross each other. This fact may be alleged as a proof in favour of the opinion of these veins having been formed successively, and in open fissures. But if these veins have been formed in the manner of crystals, the crossing may be accounted for on the same principle as that used for explaining the crossing observed in groups of crystals. If this mode of explanation should be thought satisfactory, then it would follow, that the different venigenous, metalliferous and stony formations in a district, may be of cotemporaneous formation.

8. Cotemporaneous veins are observed to occasion shifts in the veins they cross. This also is a

fact which might be stated as inconsistent with the idea of these veins having been formed without previously existing rents, if we did not know that similar shifts occur in cotemporaneous groups of crystals.

9. Some cotemporaneous veins are crossed in part of their course by a portion of the stratified matter in which they are contained: thus, veins of granite or gneiss are crossed by portions or thin beds of the gneiss. This fact is illustrative of the formation of veins without previously existing rents. Similar appearances occur in crystals, as in those of schorl and tremolite. The metalliferous veins in the Derbyshire limestone, which are frequently interrupted by beds of trap, are probably appearances of the same kind.

III. *On Coal.*

The generally received opinion in regard to the formation of this substance, is, that it is vegetable matter more or less changed by natural processes but little known to us. But the occurrence of coal in primitive country, where no organic remains have hitherto been discovered, and the particular geognostic relations of this mineral, incline me to believe, that glance-coal, and also black-coal, are original chemical deposites, as little connected with vegetable remains as the shells, &c. in limestone, are with the limestone in which they are

contained; but that brown-coal is formed from vegetable remains. The following facts countenance the opinion just stated:

1. Glance-coal occurs in primitive country, in gneiss, mica-slate, and clay-slate, and is so associated with these rocks, as to be of cotemporaneous formation with them.

2. Glance-coal occurs also in transition rocks, where it is sometimes associated with vegetable remains, but these are few in number, and of but rare occurrence, and evidently bear the same relation to the coal which the petrifactions of shells and corals, in the transition limestone, bear to the limestone in which they are contained.

3. Glance-coal occurs also in flœtz rocks, and is accompanied with more vegetable remains than in transition country, just as the shells in flœtz-limestone are more numerous than in transition limestone.

4. Black-coal occurs only in flœtz country, and there it is frequently associated with vegetable remains; but these do not bear a greater proportion to the coal than the shells, &c. in flœtz-limestone bear to the limestone.

5. Black-coal occurs in veins, and these are of cotemporaneous formation with the basaltic or sandstone rocks in which they are contained;—a fact, which proves, that, in this instance at least, coal is an original formation unconnected with vegetable remains.

6. Black-coal occurs in concentric lamellar concretions,—a character which points out its crystalline nature.

7. Some varieties of black-coal appear to have a determinate form, thus indicating their deposition from a state of solution.

8. The vegetable origin of brown-coal is shewn by its whole mass being either entirely composed of vegetable remains, or by those remains occurring in it in a preponderating quantity.

XVII. *Observations on the Natural History of the Colymbus Immer.*

By Dr ARTHUR EDMONDSTON.

(Read 27th April 1811.*)*

THE natural history of the Ember or Imber Goose, is but imperfectly known, and the place of its breeding, and whether it can fly, have been the subject of much speculation. I shall relate a few facts respecting this bird, the accuracy of which, as they are the result of personal observation, may be depended upon.

The imber varies in size and weight according to its age. The full grown bird measures often four feet and nine inches from the tip of one wing to that of the other, and three feet from the point of the beak to the extremity of the tail. The weight too, varies from seven to ten, and even

twelve pounds. The upper part of the plumage is of a bluish-black colour, and the feathers being edged with white, the whole has a speckled appearance. The under-part of the neck, breast, and belly, are of a silvery whiteness, but a dark-coloured bar crosses the vent. There is scarcely any difference of plumage in the sexes, but I think the male is the larger bird of the two.

The imber possesses great strength, swims with amazing rapidity, and is capable of remaining a long time under water; when it dives, it moves by it's feet only, and I have known it in this manner, to traverse a space of more than 200 yards, without performing a single respiration. It feeds entirely on fish. The note is wild and melancholy; and when wounded, and in dread of being taken, it utters a cry not unlike to the human voice.

In the month of November, the imber geese are frequently met with in the bays in the Zetland Islands, in small flocks of four, five, and six, but the individuals composing them seldom approach close to one another. Afterwards they associate in pairs; and in the middle of winter and spring they are commonly met with singly. From the middle of summer to the end of autumn, they are rarely seen, and this is the time when it would appear they leave the country for the purpose of propagating and rearing their species. The circumstances of this bird being said never to fly, nor to be met with on shore, have given

rise to the whimsical notion that it hatches its eggs under its wings.

I had long thought that the colymbus immer was a migratory bird, and that, therefore, it necessarily must fly; but being a most perfect diver, that it never had recourse to its wings, unless when some urgent instinct induced it to employ them. Indeed, I had often seen birds which I took to be imber-geese, fly, and nothing but the prevailing belief to the contrary led me to suppose that I might be mistaken. Lately, I had an opportunity of ascertaining the truth of a part of this opinion. On the 31st of January 1811, I saw an imber-goose in Bressa Sound, and after a good deal of trouble, I got sufficiently near to fire at, and wound it. Immediately after receiving the shot, it dived, but in a few minutes thereafter, it came to the surface, raised itself with great ease from the water, and flew with rapidity above 100 yards from the place from which it rose; when, exhausted by the loss of blood, it fell, and was soon after laid hold of. When on wing, I observed it to droop the head and tail a little, in the manner that the Colymbus septentrionalis does. I have sent the skin, imperfectly stuffed, to the Society, and the following is a description of the bird:

It measured two feet seven inches and a half from the point of the bill to the extremity of the

tail; and four feet five inches between the tips of the wings. Its weight was seven pounds and a half. The bill is straight, pointed, very strong, and measures four inches from the side of the mouth to the extremity. The upper mandible projects a little beyond the under one, and is black on its superior ridge. The under mandible is of a light blue colour. The nostrils are placed near the base of the upper mandible, and are divided near the middle by a cartilaginous kind of bar, which arises from the upper, and goes across, but is not inserted into the under mandible. The irides are of a beautiful bay-brown, bounded by a light blue line almost as broad. Back from the latter, or the sclerotic, is another brown circle, nearly of the dimensions of the iris, but less deep in the colour. The external border of the eyes is white. The upper part of the head and sides of the face, are black and grey mixed. The chin is white. The upper part of the throat grey and white. The neck is of a dusky grey and white. The breast and belly are white, and have a glossy appearance. A blackish bar crosses the vent. The tail is very short. The shoulders and scapulars are of a mixture of black and ash colour, and most of the feathers are tipped with white. The inner coverts are white. The feathers on the back and rump are short, and of a dusky-ash colour, inclining to brown. The feet and legs are large

and strong, of a leaden colour on the fore, and black on the back parts.

As this description agrees in almost every particular with that given by ornithologists of the Colymbus Immer, with the exceptions of a slight difference in the size and weight, I am disposed to consider it as a young bird that had not attained the full growth. Indeed, there is a very obvious difference in the size of these birds, which, as it is more generally perceptible about the middle of winter than at any other period of the year, may fairly enough be referred to a difference of age.

Although the imber may be looked upon as one of those birds which is generally regular in its migration from Zetland for the purpose of breeding, yet I am disposed to believe that a few actually breed in this country. A clergyman, who has bestowed a good deal of attention in studying the habits and economy of birds, assures me, that he has, on different occasions, in the middle of summer, seen an imber-goose, accompanied by two young ones; and an intelligent fisherman told me, that he once surprised a bird, which he affirmed to be an imber, on its nest, on a small islet or *holm* several miles from the shore. The nest was carelessly constructed among tufts of high grass very near to the sea, and contained three large eggs of a dark olive colour, spotted with black.

From thus having ascertained that the Colymbus Immer can fly, and that it is regular in its disappearance from Zetland in the breeding season, we can easily reconcile the apparently opposite statements given by ornithologists respecting the diversity of situation in which it has been said to have been met with.

XVIII. *Contributions to the British Fauna.*

By the Rev. John Fleming, F. R. S. E.

1. *Sorex fodiens*, or *Water Shrew.*

Brit. Zool. vol. i. p. 126.—Plate xi. No. 33.

Weight, 128 grains*. Length of the body, 3 inches. Tail, 2 inches. Above, black. Beneath, grey. Snout, long and a little compressed. Whiskers, long. Eyes small, concealed in the fur, with a small white spot above each. Ears likewise minute, with a paler tuft on the inside. In the middle of the throat, a black spot. A narrow stripe of black along the belly. At the base of the tail, a triangular black spot. Inside of the feet and legs white; the outer side black, con-

* Weight of another specimen recently obtained, 186 grains.

nected with the back. Tail pointed covered with very short hair, with a crest or ridge on the under side, of paler-coloured hair. The fore-teeth are two in number, and long, especially in the lower jaw.

Although usually described as an inhabitant of moist places, it would appear that this shrew occasionally prefers other situations. The specimen above described, was found dead on the top of a ridge of dry hills on the 3d September 1812. Mr Montagu appears likewise to have observed it in a similar situation, as appears from his remarks on this species.—(*Linn. Trans.* vol. viii. p. 276.)

This species chiefly frequents fields of clover and strong oats. It is by no means rare in the county of Fife.

Merret, in his *Pinax rerum naturalium Britannicarum*, p. 167. in all probability refers to this species, when enumerating the varieties of the common shrew, (Sorex araneus.) "Invenitur (he says) nigri vel fusci coloris, *et alter dorso nigro ventreque albo*, et parvus, griseus, et in partibus borealibus magnus, cauda brevi."

Our countryman Sir Robert Sibbald does not appear to have been acquainted with this animal, unless we suppose that he refers to it when he says, "varii mures sylvatici apud nos: quidam dorso nigro qui talpas occidit."

In the sketch of Caledonian Zoology, composed by Mr Pennant, and prefixed to the Flora Scotica

of Lightfoot, this shrew is mentioned as being an inhabitant of Scotland and the islands. He says it is the "*Lavellan* of some places; supposed to be noxious to cattle." In his British Zoology, however, he expresses himself with somewhat less confidence. When speaking of this animal, he says, "I *imagine* it to be the same that the inhabitants of Sutherland call the Water-Mole, and those of *Cathness the Lavellan;* which, the last imagine, poisons their cattle, and is held by them in great abhorrence."

It appears from Sibbald's description of the lavellan of Caithness, that Pennant has perhaps referred it too hastily to the species now under consideration. "Lavellan, (he says), animal in Cathanesia frequens, in aquis degit, *capite mustelæ sylvestri simile, ejusdemque coloris bestia est.*"—(*Scotia ill.* p. 11.) Noxious properties are ascribed to it. "Halitu bestiis nocet, remedium autem est si de aqua bibant in qua ejus caput coctum sit." The head of the water-shrew is by no means similar to the weasel, (*Mustela vulgaris L.*); neither is it a beast of the same colour. What then is the Lavellan of Caithness? Should it be considered as the Water Shrew?

The late Dr Walker appears to have been unacquainted with this animal as an inhabitant of Scotland, as no place is assigned to it in his *Mammalia Scotica,* lately published in his posthumous volume of Essays.—(Communicated 5th December 1812.)

2. *Pleuronectes punctatus.*

* Eyes on the left side of the head.

The length of the specimen in my possession, is five inches and a half from the nose to the point of the tail; and the breadth, two inches and six-eighths. Jaws nearly equal; teeth small; upper lip retractile and protrusile. Eyes middle-sized. The lateral line, which is rather indistinct, begins a short way behind the crown of the head, is much bent above the pectoral fin, and then proceeds in a straight line to the tail. The dorsal fin consists of seventy-nine rays, with the first of them longer than those which immediately follow. The pectoral fins contain nine rays; but in the under fin, one of the rays is remarkably short. The ventral fins consist of six rays. The anal fin is composed of sixty-eight rays. The caudal fin consists of seventeen rays, and is a little rounded.

The body and fins are closely covered with imbricated and denticulated scales. The denticles of the scales are from four to eight in number. Colour black, mottled with brown on the upper side, with a few scattered reddish spots. Beneath white, without any markings.

This specimen had not attained its full size. I found it on the 18th January 1810 in a fishing-boat, in Bixter-voe, Zetland.

This species appears to have been confounded by Gmelin, Shaw, and others, with the Whiff of

Ray. The characters which distinguish the two species, are sufficiently obvious, and have been pointed out with great perspicuity by Mr Donovan in his *History of British Fishes*, Plate li. when describing the Whiff of Ray.—(Communicated 9th December 1809.)

3. *Lepas fascicularis*.—Plate xvii. fig. 4.

Colour bluish-white, somewhat glossy. The first valve is narrow at the top, gradually swelling downwards to about one-third of its length from the base, where it forms an acute knob or apex; it then bends inwards, and increases in breadth to the base, where it is shaped like a hatchet. It has an elevated keel, which in some specimens extends from the knob to the top, and in others through the whole length of the shell. It is wrinkled, and the wrinkles are parallel to the margin, and diverge from the knob towards the edge. The large valves are obtusely triangular, with furrows parallel to the inner margin, and are divergingly streaked from the under point. They project a little at the base. The two upper valves are triangular, furrowed parallel to the inner margin, and are divergingly streaked from the upper point, which is a little produced and recurved. The valves are connected together by a transparent colourless skin. The peduncle is from half an inch to near a foot in length, thin, pellucid, smooth, and of a dusky colour when the

transparent and brittle, is about an inch and a half in length.

This shell, like several of its congeners, is gregarious, and is usually found in clusters attached to a white gelatinous spherical substance, which adheres to various bodies.

The most curious circumstance in the history of this species, is the rapidity of its growth. The gelatinous substance from which the peduncles that support the shells proceed, is found adhering to various species of fuci, pieces of wood; and what is still more remarkable, I once observed full grown specimens adhering to the quill-feather of a gull. The feather seemed very entire and fresh. *Flustra membranacea* sometimes covers it all over, and so completely incloses the mouth of the shell, as to destroy the inhabitant. It is likewise infested with *Sertularia geniculata**.

This shell was first observed by Ellis previous to the year 1776, and figured by him (*Ellis*, Zooph. tab. 15. fig. 6.) from a specimen from St George's

* Pallas, when speaking of Loefling's observations on Sertularia geniculata, says, "Vitam torpidissimam habere polypos dicit, ut acu tacti vix sensibilitatis dent signa." *Elenchus Zooph.* p. 119. This character of torpidity is by no means applicable to the S. geniculata of Ellis. When I touched the animals of this coralline with a needle, they speedily retired within the cavity of their cups; and when pulling away a small ascaris, which, by its motions, disturbed my observations with the microscope, it was instantly seized and devoured by one of these animals.

Channel. It has since been found on the English shores by the late Mr Bryer, and by Mr Montagu. I observed it among the Zetland Islands in 1808. It is thrown ashore in great abundance during the gales of autumn *.

Mr Donovan, in his British Shells, has figured a shell which he considered the same as the Lepas fascicularis of Ellis, but to which he gave the name of *L. dilata.* The figures of the two shells are essentially distinct, and never could have been given as representations of the same species. The pointed reflected apex of the upper valves, so characteristic of the Ellisian species, is not expressed in Donovan's figure, where the apex appears blunt. A short way below the upper extremity of the dorsal valve, there is represented in Donovan's figure, a sudden enlargement of the keel, which continues until the valve bends inwards to join the peduncle. In L. fascicularis, the keel gradually increases in size from the upper extremity of the dorsal valve, until it forms a small knob, where the valve bends inwards. Is the Lepas dilata of British Shells, therefore entitled to hold a place in the British Testacea?—(Communicated 9th December 1809.)

* Since writing the above, specimens of this lepas, adhering to the stems of Fucus nodosus, have been picked up, in the Minch, between the Mainland and Harris Isles, by my friend Robert Stevenson, Esq.

4. *Hirudo verrucosa.*

Encyclop. 7e Liv. des Pl. d'Hist. Nat.—Helminthologie, Pl. 52. fig. 5.

Head dilated; margin smooth, with six small tubercles or warts. Body round, thickest at the base, tapering towards the head, and composed of numerous warty rings. There are upwards of fifty large rings, with many intermediate smaller ones. These rings are studded in the middle with about twelve retractile warts. Tail nearly the size of the head, smooth and dilated. Length when stretched, nearly one foot.

Found on the skate and thornback in Zetland and Leith. It leaves a black mark behind; and after being removed, is very tenacious of life.

This species bears a near resemblance to the *H. muricata* of Linnæus. It may even prove to be the same, as I have never seen any specimen which I was convinced was the true H. muricata. The figure of H. muricata, as given by Linnæus in the *Museum Adolphi Friderici*, (and afterwards copied by Pennant into his *British Zoology*,) possesses two horns or teeth, which are very conspicuous, and the head is considerably smaller than than the tail. In the species above described, there are no appearances of horns or teeth, and the head is dilated, and nearly of the size of the tail.

The drawing of Bruguière, referred to above, exhibits a very just representation of the general appearance of the animal. He has omitted to delineate the small marginal tubercles of the mouth.

The genus *Hirudo*, as well as many of the genera of the class *Annelides*, is in great confusion. The present species, and *H. muricata*, certainly differ in habit and external characters from the fresh-water species of leeches, and ought to constitute a separate genus. Unless such subdivisions of many of the Linnean genera take place, each genus of the *Systema Naturæ* will assume the rank of an order, and the families will occupy the station of genera.—(Communicated 9th December 1809.)

5. *Echinus miliaris.*

Shell whitish, tinged with violet. The avenues of the pores in pairs, dividing the shell into five small, and five large spaces. The pores are placed in pairs, obliquely disposed in three rows. The smaller spaces have a row of protuberances, the seats of primary spines, on each side close to the pores, with the centre nearly smooth, or covered with very minute spines, divided by a zig-zag line down the middle. These spaces do not reach the top or vertex. The larger spaces are divided by a suture from the vertex to the mouth, more distinct than in the smaller spaces, with horizontal

sutures joining a line, which runs along the side of the pores, thus forming rhomboidal compartments. In the centre of each of these compartments, there is a large tubercle, with a few smaller ones. Thus, there are but two rows of spines in each of the spaces between the pores. The sides and middle of the larger spaces are nearly smooth. *Anus* vertical, circular, a little raised, closed by a coriaceous wrinkled muricated lid. Mouth beneath, central, circular, covered with a thick skin, beset with tufts of small spines.

This is a more depressed species than the *E. esculentus*. The spines are by no means so numerous, and a part of the spaces between the pores is smooth, which, in the other, is thickly set with spinules. The teeth resemble those of E. esculentus, but the jaws are a little more obtuse. The spines are stronger, blunt, finely streaked, and some of them are upwards of an inch in length.

This specimen was found in deep water at the mouth of Sellavoe, Zetland, where I have also observed the following species: *Echinus esculentus*, there called *Scaad* (scabbed) *man's head.* A species nearly allied to *E. spatagus*, termed the *sea-mouse*. *E. cidaris*, or *Piper*. The two last inhabit deep water. *E. pusillus*, often cast ashore, but never found with the spines. Professor Jameson found the *E. placenta*. I never observed the *E. lacunosus* in Zetland, although it is frequent in the Frith of Forth.—(Communicated 9th December 1809.)

6. *Lucernaria fascicularis.*

Plate xviii. fig. 1, 2.

Substance gelatinous; colour dark-brown, nearly opake. Tail cylindrical, flexuous, wrinkled, extensile, and somewhat narrower at the base, where it adheres to broad-leaved *Fuci*. Body bell-shaped, sub-quadrangular, concave within. Margin divided into four arms, which are broad at the base, divided at the top, and concave within. On the top of each of the divisions of the arms, there is a fasciculus of tentacula, upwards of a hundred in number. The mouth is placed in the centre, and consists of a loose tubular membrane, sometimes four-notched at the tip, but often, at the pleasure of the animal, expanded, circular, or striated.

Internally, the animal appears to be divided into four compartments, reaching from the centre to the margin between the arms. The divisions are formed by a thin membrane from the four corners of the mouth. On each side of these divisions, a thick corrugated band extends from the centre, almost to the border of the margin. The bands are the intestines of the animal. The inside of the mouth contains numerous white filaments.

The animal contracts itself into various shapes. It moves the tentacula very quickly, especially if muddy water is poured upon it. Although

I have kept it alive several days, I have never observed it in an upright position. It in general hangs downwards, as expressed in the figure, sometimes, however, it is nearly horizontal.

It is chiefly found on the leaves of *Fucus digitatus*, and *F. esculentus*, which grow in deep water. It is common in Zetland.

At first I was disposed to consider this species as the *Lucernaria quadricornis* of Müller, (Zool. Dan. i. tab. 39. fig. 1.); but a more careful comparison of the figure and description with the Zetland specimens, has convinced me of the propriety of viewing them as distinct species. In *L. quadricornis*, the branches of the arms are represented as terminating in a fasciculus of about forty tentacula; whereas, in *L. fascicularis*, the tentacula are upwards of a hundred in number.—(Communicated 9th December 1809.)

7. *Caryophyllia cyathus*. (Lamark.)

Madrepora cyathus.—*Ellis*, Zooph. p. 184. tab. 28. fig. 1—4.

Coral white, hard, striated on the outside, and rough. Margin denticulated by the plates of the gills. Star oval, containing forty or fifty gills, with an equal number of intermediate smaller ones; the latter reaching to the margin, but not to the centre as the larger ones do. In the centre of the star, there is a prominent ridge in the direction of its greatest diameter. This ridge is com-

posed of curled plates on each side, of a substance similar to the plates of the gills.

I have only observed two specimens of this zoophyte, which I found in a fishing-boat in the Island of Papa Stour, Zetland, the 3d August 1808. They were taken up from deep water on the cod-lines in the fishing ground off Foulah. The largest of the two specimens, was half an inch in height, six-tenths in length, and four-tenths in breadth. They were both attached to a dead shell of *Pecten opercularis*, along with *Balanus intertexa*, and *Serpula tubularia*.

8. *Fungia turbinata.* (Lam.)

Madrepora turbinata.—Lin. Syst. Nat. p. 1272—337. 6. Amœn. Acad. vol. i. p. 190. fig. 1, 2, 3, 4, 7.

In the same boat in which I found the Caryophyllia cyathus, I likewise picked up a dead specimen of this coral somewhat defaced. It was of the shape of an inverted cone, with the base pointed. The star appeared to have been concave with entire gills. It was about five-tenths of an inch in height, and about the same in breadth at the top.

From its shape, it appears probable, that it grows with its base fixed in the sandy bottom of the sea, as Pallas formerly conjectured.

9. *Flustra Ellisii.*

Pl. xvii. fig. 1. nat. size, fig. 2. mag., fig. 3. side view.

Substance firm, brittle, and gritty when dry. Colour yellowish-white. The base consists of small horny tubuli, by which it is fixed. These tubuli unite, and form narrow linear leaves dichotomously branched. The branches are somewhat rounded and celliferous above. The under side is carinated, and destitute of cells. The tubuli or fibres of which the substance is composed on the under side, can be distinctly seen diverging from the keel towards the edge of the leaf, and forming two small denticles and a bristle on the upper side of each lateral cell. These bristles are about three times the length of the diameter of the branches, and are finely denticulated on one side. The cells are oval, and obliquely disposed in two or three rows.

This Flustra was brought up by the cod-lines from a hundred fathoms water, off Stenhouse, in the parish of Northmavine, Zetland, in July 1808. It was growing on an aged specimen of *Eschara cervicornis*, in company with *Retepora cellulosa*.

As this Flustra appears to be a new species, I have named it in honour of Mr Ellis, that able investigator of the natural history of Zoophytes, whose works exhibit a striking example of persevering industry, and accurate investigation.

XIX. *Description and Analysis of a new Species of Lead-Ore from India.*

By Thomas Thomson, M. D. F. R. S. L. & E. F. L. S. Fellow of the Geological Society, of the Wernerian Society, and of the Imperial Chirurgo-Medical Academy of Petersburgh.

(*Read* 12*th February* 1814.)

The ore which constitutes the subject of this paper, was brought by Dr Heyné from Madras, where it is sold in the shops for medical purposes. He thinks it probable that it comes originally from Malacca, or the Island of Sumatra. As it differs in its constituents from every species of ore hitherto observed in Europe, it will not be amiss to lay a description of it, together with the result of its analysis, before the public.

The external colour of the specimen which I examined, was blackish-blue, with green stains here and there, indicating very clearly, the presence of copper. When broken, it exhibits the

appearance of steel-grained galena, only the colour is darker, and it shews the granular concretions which distinguish that variety of sulphuret of lead. But, in a few days, this fracture tarnishes, loses its metallic lustre, and speedily becomes similar to the external surface of the specimen.

The fracture is small-grained uneven. The external lustre glimmering, and semi-metallic. The internal lustre splendent and metallic. Soft, easily scratched by a knife. Streak, lead-blue. Rather sectile. Specific gravity, 6.590. But Dr Heyné informed me, that he had found pieces as light as 4.9.

Strong nitric acid acts upon this ore, when reduced to powder, with great violence; but when the acid is diluted with water, the action is scarcely perceptible.

A hundred grains of the ore in the state of powder, were treated with an ounce measure of strong nitric acid. The action was so violent, that I was obliged to moderate it by the addition of water. When this portion of acid ceased to act, it was decanted off, and an additional portion substituted in its place. After two days, all action was at an end. Part of the ore was dissolved, and part was in the state of a white powder. This white powder being separated by the filter, washed and dried in the open air, weighed 58.5 grains. When exposed to the heat of a lamp on a watch-glass, it gave out fumes of sulphur, and the weight was reduced to

54.8 grains. The 3.7 grains driven off, I consider as sulphur.

The white powder was now exposed to a red heat in a platinum crucible, but it did not lose any weight. Before the blow-pipe, upon charcoal, it was speedily reduced, and a button of metallic lead obtained. It was easy to recognize by these properties, that the powder was sulphate of lead.

The acid liquor being evaporated nearly to dryness, an additional portion of white powder separated, which, being washed and dried, weighed 16.6 grains. It was likewise sulphate of lead.

Thus, 100 grains of the ore yielded 71.4 grains of sulphate of lead. Now, this salt is a compound of

Yellow oxide of lead,		52.61
Sulphuric acid,	-	18.79
		71.40

From the table given in the *Annals of Philosophy*, vol. ii. p. 42., it is easy to see that 52.61 grains of oxide of lead, contain 48.849 grains of lead. From the same table, we may ascertain, that 18.79 grains of sulphuric acid contain 7.516 grains of sulphur.

The liquid from which the last portions of sulphate of lead had been separated, being set aside for a few days, let fall small tetrahedral crystals of a white colour, which I recognized by their form to be nitrate of lead. They weighed 2.13 grains, and contained 1,21 grains of lead. Thus, the

whole lead obtained from the 100 grains of ore, amounted to 50.059 grains.

The solution being mixed with some nitrate of barytes, become slightly muddy, and let fall a white powder, insoluble in nitric acid, and therefore sulphate of barytes. It weighed 0.8 grain, and contained 0.112 grain of sulphur. The presence of sulphuric acid, in a solution from which nitrate of lead had separated in crystals, is curious. I do not see how it can be accounted for, unless we suppose Berthollet's principle of the effect of mass to be to a certain amount true. For there was present in the liquid, an enormous excess of nitric acid, when compared with the quantity of sulphuric acid. Thus, the whole sulphur obtained from the 100 grains of ore, amounted to 11.328 grains.

The nitric acid solution, which had a bluish-green colour, was now mixed with 90 grains of sulphuric acid, and distilled in a retort almost to dryness, to get rid of the nitric acid. The residue was dissolved in water, and a plate of zinc being introduced, was allowed to remain till the liquid lost entirely its blue colour, and assumed the light-green tinge, which indicates the presence of iron. Diluted muriatic acid was now poured upon the plate of zinc, till it was completely dissolved. The copper thrown down by this process, being dried and weighed, was found to amount to 32.5 grains.

A plate of fresh zinc was introduced into the green solution, and allowed to remain till the colour was entirely removed. Yellowish-red flocks were thrown down, which being washed, dried, and weighed, amounted to 2 grains. Being dissolved in muriatic acid, and mixed with prussiate of potash, the whole was precipitated in the state of Prussian blue. Hence it consisted of red oxide of iron. But 2 grains of red oxide of iron, are equivalent to 1.37 grain of iron.

Thus it appears, that the constituents of the ore were as follows:

Lead, -	50.059
Copper, -	32.500
Iron, - -	1.370
Sulphur, -	11.328
Loss, - -	4.743
	100.000

If we conceive the loss in the preceding analysis to have been sulphur, which I think probable from the violent action of the first portion of nitric acid, the ore was nothing else than a mixture or combination of the sulphurets of lead, copper, and iron, in the following proportions:

Sulphuret of lead,	-	57.269
Sulphuret of copper,	-	40.850
Sulphuret of iron,	-	2.190
		100.309

That this ore is not a mere mechanical mixture of these sulphurets, I conceive proved by this circumstance. I attempted in vain to separate the sulphuret of copper from the sulphuret of lead, by washing the powdered ore upon an inclined plane. Yet the specific gravity of these two sulphurets, is so different, that their mechanical separation ought to be easy, unless they be chemically combined. Now, it deserves attention, that the ore, (neglecting the small quantity of sulphuret of iron, which is probably accidental,) consists of one integrant particle of sulphuret of lead, combined with two integrant particles of sulphuret of copper. Hence I am disposed to consider this ore as constituting a new species of lead-ore,—a species, however, of comparatively little value in a metallurgic point of view; because lead and copper are mutually injurious to each other, and it would be difficult to devise cheap methods of separating them.

As this ore has only been met with in apothecaries shops, and as we are ignorant of any mine of it actually existing, it may be supposed perhaps to be an artificial combination. From the appearance of the specimen which I examined, no

such conclusion could be drawn. It had all the characters of a natural production. At the same time, it would be worth while to make a few experiments, in order to determine whether a similar substance could be obtained by melting together sulphurets of lead and copper in the requisite proportions.

XX. *Notice concerning the Structure of the Cells in the Combs of Bees and Wasps.*

By Dr Barclay.

(*Read* 18*th January* 1812.)

Having inquired of several naturalists, whether or not they knew any author who had mentioned, that the partitions between the cells of the honeycomb were double, and whether or not they had ever remarked such a structure themselves; and they having answered in the negative; I now take the liberty of presenting to the Society pieces of honeycomb, in which the young bees had been reared, upon breaking which, it will be clearly seen that the partitions between different cells, at the sides and the base, are all *double;* or in other words, that each cell is a distinct, separate, and in some measure an independent structure, agglutinated only to the neighbouring cells; and that when the agglutinating substance is destroyed, each cell may be entirely separated from the rest.

I have also some specimens of the cells formed by wasps, which show, that the partitions between them are also double, and that the agglutinating substance between them is more easily destroyed than that between the cells of the bee.

I confess, that I do not know whether this structure has been observed by others before me; but whether it has or not, I claim no merit for the discovery, as I was led to remark the structure by mere accident, and not from any previous investigation.

XXI. *On the Greenland or Polar Ice.*

By William Scoresby *junior*, M. W. S.

(*Read* 11*th March* 1815.)

Introduction.

Greenland* is a country where every object is strikingly singular, or highly magnificent. The atmosphere, the land, and the ocean, each exhibit remarkable or sublime appearances.

With regard to the *atmosphere*, several peculiarities may be noticed, viz. its darkness of colour

* The name *Greenland*, is here to be taken in its common and most general acceptation, which is meant to signify, not only Greenland properly so called, but more especially the land of Spitzbergen and adjacent islands, together with the seas intermediate between these two coasts, extending from the farthest navigable point north, to the southern margin of all ice; or by act of Parliament, to 59° 30′ N. latitude.—26th Geo. III. c. 41. § 16.

and density; its frequent production of crystallised snow in a wonderful perfection and variety of form and texture; and its astonishing sudden changes from calm to storm,—from fair weather to foul, and *vice versâ.*

The *land* is of itself a sublime object; its stupendous mountains rising by steep acclivities from the very margin of the ocean to an immense height, terminating in ridged, conical, or pyramidal summits; its surface, contrasting its native protruding dark-coloured rocks, with its burthen of purest snow; the whole viewed under the density of a gloomy sky, forms a picture impressive and grand. Its most remarkable inhabitant is the White or Polar Bear, which indeed also occurs on the ice. This ferocious animal, seems to be the natural lord of those regions. He preys indiscriminately on quadruped, fowl, reptile, and fish; all behold him with dread, and flee his presence. The seals signify their fear of him by their constant watching, and betake themselves precipitately to the water on his approach. Carrion, therefore, (of which the carcase of the whale is at a certain season the most plentiful), affords him a passive, sure, and favourite food. His sense of smelling is peculiarly acute: in his march, he is frequently observed to face the breeze, to rear his head, and snuff the passing scent, whereby he

can discover the nearest route to his odorous banquet, though the distance be incredibly great.

The *water* of the ocean, is not the least interesting of the elements, particularly as affording the bed, and partly the materials for the most prodigious masses of ice. Its colour is peculiar. Its products are numerous, and of particular importance. It is here that the huge Mysticetus, or Whalebone Whale, takes up his residence, and collects his food ;—it is here that he sports and astonishes, by his vast bulk and proportionate strength ;—and it is here that he becomes the object of maritime adventure, and a source of commercial riches.

Ice, an interesting production.

Of the inanimate productions of Greenland, none perhaps excites so much interest and astonishment in a stranger, as the *ice* in its great abundance and variety. The stupendous masses, known by the name of *Ice-Islands*, *Floating-Mountains*, or *Icebergs*, common to Davis' Straits and sometimes met with here, from their height, various forms, and the depth of water in which they ground, are calculated to strike the beholder with

wonder: yet the *fields* * of ice, more peculiar to Greenland, are not less astonishing. Their deficiency in elevation, is sufficiently compensated by their amazing extent of surface. Some of them have been observed near a hundred miles in length, and more than half that breadth; each consisting of a single sheet of ice, having its surface raised in general four or six feet above the level of the water, and its base depressed to the depth of near twenty feet beneath.

The various kinds of Ice described.

The ice in general, is designated by a variety of appellations, distinguishing it according to the size or number of pieces, their form of aggregation, thickness, transparency, &c. I perhaps cannot better explain the terms in common acceptation amongst the whale-fishers, than by marking the disruption of a field. The thickest and strongest field cannot resist the power of a heavy swell; indeed, such are much less capable of bending without being dissevered, than the thinner ice which is more pliable. When a field, by the set of the current, drives to the southward, and being deserted by the loose ice, becomes exposed to the effects of a *grown* swell, it presently breaks into a

* A *field* is a continued sheet of ice, so large, that its boundaries cannot be seen from the summit of a ship's mast.

great many pieces, few of which will exceed forty or fifty yards in diameter. Now, such a number of these pieces collected together in close contact, so that they cannot, from the top of the ship's mast, be seen over, are termed a *pack*.

When the collection of pieces can be seen across, if it assume a circular or polygonal form, the name of *patch* is applied, and it is called a *stream* when its shape is more of an oblong, how narrow soever it may be, provided the continuity of the pieces is preserved.

Pieces of very large dimensions, but smaller than fields, are called *floes*: thus, a *field* may be compared to a *pack*, and a *floe* to a *patch*, as regards their size and external form.

Small pieces which break off, and are separated from the larger masses by the effect of attrition, are called *brash-ice*, and may be collected into streams or patches.

Ice is said to be *loose* or *open*, when the pieces are so far separated as to allow a ship to sail freely amongst them; this has likewise been called *drift-ice*.

A *hummock* is a protuberance raised upon any plane of ice above the common level. It is frequently produced by pressure, where one piece is squeezed upon another, often set upon its edge, and in that position cemented by the frost. Hummocks are likewise formed, by pieces of ice mutually crushing each other, the

wreck being coacervated upon one or both of them. To hummocks, the ice is indebted for its variety of fanciful shapes, and its picturesque appearance. They occur in great numbers in heavy packs, on the edges and occasionally in the middle of fields and floes. They often attain the height of thirty feet or upwards.

A *calf*, is a portion of ice which has been depressed by the same means as a hummock is elevated. It is kept down by some larger mass; from beneath which, it shews itself on one side. I have seen a calf so deep and broad, that the ship sailed over it without touching, when it might be observed on both sides of the vessel at the same time; this, however, is attended with considerable danger, and necessity alone warrants the experiment, as calves have not unfrequently (by a ship's touching them, or disturbing the sea near them) been called from their sub-marine situation to the surface, and with such an accelerated velocity, as to stave the planks and timbers of the ship, and in some instances, to reduce the vessel to a wreck.

Any part of the upper superficies of a piece of ice, which comes to be immersed beneath the surface of the water, obtains the name of a *tongue*.

A *bight* signifies a bay or sinuosity, on the border of any large mass or body of ice. It is supposed to be called *bight* from the low word *bite*, to take in, or entrap; because, in this situation,

ships are sometimes so caught by a change of wind, that the ice cannot be cleared on either tack; and in some cases, a total loss has been the consequence.

Comparison of Ice frozen from Sea-Water and Rain-Water.

When the sea freezes, the greatest part of the salt it contains is deposited, and the frozen spongy mass probably contains no salt, but what is natural to the sea-water filling its pores. Hence, the generality of ice affords fresh-water, when dissolved. As, however, the ice frozen from sea-water does not appear so solid and transparent as that procured from snow or rain-water, sailors distinguish it into two kinds, accordingly as it seems to have been formed from one or the other.

Ice frozen from Sea-Water.

What is considered as *salt-water ice*, is porous, white, and in a great measure opaque, (except when in very thin pieces), yet transmits the rays of light with a greenish shade. It is softer, and swims lighter than fresh-water ice, and when dissolved, produces water sometimes perfectly fresh, and sometimes saltish; this depends in a great measure on the situation from whence it is taken: such parts as are raised above the surface of the sea in the form of *hummocks*, appear to gain

solidity by exposure to the sun and air, and are commonly *fresh*, whilst those pieces taken out of the sea are somewhat salt. Although it is very probable, that this retention of salt may arise from the sea-water contained in its pores, yet I have never been able to obtain, from the water of the ocean, by experiment, an ice either compact, transparent, or fresh. That the sea-water has a tendency to produce fresh ice, however, is proved from the concentration observed in a quantity exposed in an open vessel to a low temperature, by the separation of the salt from the crystals of ice, in the progress of the freezing. Thus it is, that in the coldest weather, when a ship exposed to a tempestuous sea, is washed with repeated *sprays*, and thereby covered with ice, that in different places obstructing the efflux of the water overboard, a portion always remains unfrozen, and which, on being tasted, is found to contain salt highly concentrated. This arises from the freezing point of water falling in a certain ratio according to the degree of saltness; thus, though pure water, of specific gravity 1.0000, freeze with a temperature of 32°, water of specific gravity 1.0263, containing about $5\frac{3}{4}$ oz. (avoird.) of salt in every gallon of 231 cubic inches, that is, with the degree of saltness common to the Greenland Seas, freezes at $28\frac{1}{2}$°. Sea-water concentrated by freezing, until it obtains the specific gravity of 1.1045, requires a temperature of $13\frac{1}{3}$° for its

congelation, having its freezing point reduced $18\frac{1}{3}°$ below that of pure water; and water saturated with sea-salt remains liquid, at a temperature of —4°.

Thus, we are presented with a natural process for extracting salt from the sea, at least for greatly facilitating that process in a concentration of the saline particles, by the agency of frost.

When *salt-water ice* floats in the sea at a freezing temperature, the proportion above, to that below the surface, is as 1 to 4 nearly; and in fresh water, at the freezing point, as 10 to 69, or 1 to 7 nearly. Hence, its specific gravity appears to be about 0.873. Of this description is all *young* ice, as it is called, which forms a considerable proportion of packed and drift ice in general; where it occurs in flat pieces commonly covered with snow, of various dimensions, but seldom exceeding fifty yards in diameter.

Fresh-Water Ice.

Fresh-water ice, is distinguished by its black appearance when floating in the sea, and its beautiful green hue and transparency when removed into the air. Large pieces may occasionally be obtained, possessing a degree of purity and transparency, equal to that of the finest glass, or most beautiful crystal; but generally, its transparency

is interrupted by numerous small globular or pear-shaped air-bubbles: these frequently form continuous lines intersecting the ice in a direction apparently perpendicular to its plane of formation.

Fresh-water ice is fragile, but hard; the edges of a fractured part, are frequently so keen, as to inflict a wound like glass. The homogeneous and most transparent pieces, are capable of concentrating the rays of the sun, so as to produce a considerable intensity of heat. With a lump of ice, of by no means regular convexity, I have frequently burnt wood, fired gunpowder, melted lead, and lit the sailors' pipes, to their great astonishment; all of whom, who could procure the needful articles, eagerly flocked around me, for the satisfaction of smoking a pipe ignited by such extraordinary means. Their astonishment was increased, on observing, that the ice remained firm and pellucid, whilst the solar rays emerging therefrom, were so hot, that the hand could not be kept longer in the focus, than for the space of a few seconds. In the formation of these lenses, I roughed them with a small axe, which cut the ice tolerably smooth; I then scraped them with a knife, and polished them merely by the warmth of the hand, supporting them during the operation in a woollen glove. I once procured a piece of the purest ice, so large, that a lens of sixteen inches diameter was obtained out of it; unfortu-

nately, however, the sun became obscured before it was completed, and never made its appearance again for a fortnight, during which time, the air being mild, the lens was spoiled.

The most dense kind of ice, which is perfectly transparent, is about one-tenth specifically lighter than sea-water at a freezing temperature. Plunged into pure water, of temperature 32°, the proportion floating above to that below the surface, is as 1 to 15, and placed in boiling fresh water, it barely floats. Its specific gravity is about 0.937.

Fields, bergs, and other large masses, chiefly consist of this kind of ice. *Brash-ice* likewise affords pieces of it, the surfaces of which are always found crowded with conchoidal excavations when taken out of the sea.

On the Formation of Ice on the Sea.

Some naturalists have been at considerable pains to endeavour to explain the phenomena of the progressive formation of the ice in high latitudes, and the derivation of the supply, which is annually furnished, for replacing the great quantities that are dissolved and dissipated by the power of the waves, and the warmth of the climate into which it drifts. It has frequently been urged, that the vicinity of land is indispensable for its formation,

Whether this may be the case or not, the following facts may possibly determine.

I have noticed the process of freezing from the first appearance of crystals, until the ice had obtained a thickness of more than a foot, and did not find that the land afforded any assistance or even shelter, which could not have been dispensed with during the operation. It is true, that the land was the cause of the vacancy or space free from ice, where this new ice was generated; the ice of older formation had been driven off by easterly winds, assisted perhaps by a current; yet this new ice lay at the distance of twenty leagues from Spitzbergen. But I have also seen ice grow to a consistence capable of stopping the progress of a ship with a brisk wind, even when exposed to the waves of the North Sea and Western Ocean, on the south aspect of the main body of the Greenland ice, in about the seventy-second degree of north latitude. In this situation, the process of freezing is accomplished under peculiar disadvantages. I shall attempt to describe its progress from the commencement.

Freezing of the Ocean in a rough Sea.

The first appearance of ice whilst in the state of detached crystals, is called by the sailors *sludge*, and resembles snow when cast into water that is too cold to dissolve it. This smooths the ruffled sea, and produces an effect like oil in stilling the

breaking surface. These crystals soon unite, and would form a continuous sheet, but, by the motion of the waves, they are broken into very small pieces, scarcely three inches in diameter. As they strengthen, many of them coalesce, and form a larger mass. The undulations of the sea still continuing, these enlarged pieces strike each other on every side, whereby they become rounded, and their edges turned up, whence they obtain the name of *pancakes:* several of these again unite, and thereby continue to increase, forming larger *pancakes*, until they become perhaps a foot in thickness, and many yards in circumference.

Freezing of the Sea in sheltered situations.

When the sea is perfectly smooth, the freezing process goes on more regularly, and perhaps more rapidly. The commencement is similar to that just described; it is afterwards continued by constant additions, to its under surface. During twenty-four hours keen frost, it will have become two or three inches thick, and in less than forty-eight hours time, capable of sustaining the weight of a man. This is termed *bay-ice*, whilst that of older formation is distinguished into *light* and *heavy* ice; the former being from a foot to about a yard in thickness, and the latter from about a yard upwards.

It is generally allowed, that all that is necessary in low temperatures for the formation of ice, is still water: here then, it is obtained. In every opening of the ice at a distance from the sea, the water is always as smooth as that of a harbour; and as I have observed the growth of ice up to a foot in thickness in such a situation, during one month's frost, the effect of many years, we might deem to be sufficient, for the formation of the most ponderous fields.

There is no doubt, but a large quantity of ice is annually generated in the bays, and amidst the islands of Spitzbergen: which bays, towards the end of summer, are commonly emptied of their contents, from the thawing of the snow on the mountains causing a current outwards. But this will not account for the immense fields which are so abundant in Greenland. These evidently come from the northward, and have their origin between Spitzbergen and the Pole.

On the Generation of Fields.

As strong winds are known to possess great influence in drifting off the ice, where it meets with the least resistance, may they not form openings in the ice far to the north, as well as in latitudes within our observation? Notwithstanding the degree in which this cause may prevail, is uncertain, yet of this we are assured, that the ice

on the west coast of Spitzbergen, has always a tendency to drift, and actually does advance in a surprising manner to the south or south-west; whence, some vacancy *must* assuredly be left in the place which it formerly occupied.

These openings, therefore, may be readily frozen over whatever be their extent, and the ice may in time acquire all the characters of a massy field.

It must, however, be confessed, that from the density and transparency of the ice of fields, and the purity of the water obtained therefrom, it is difficult to conceive that it could possess such characters if frozen entirely from the water of the ocean;—particularly as young ice is generally found to be porous and opaque, and does not afford a pure solution. The succeeding theory, therefore, is perhaps more consonant to appearances; and although it may not be established, has at least probability to recommend it.

It appears from what has been advanced, that openings must occasionally occur in the ice between Spitzbergen and the Pole, and that these openings will in all probability, be again frozen over. Allowing, therefore, a thin field or a field of bay-ice to be therein formed, a superstructure may probably be added by the following process. The frost, which constantly prevails during nine months of the year, relaxes towards the end of June or the beginning of July, whereby the cover-

ing of snow, annually deposited to the depth of two or three feet on the ice*, dissolves. Now, as this field is supposed to arise amidst the older and heavier ice, it may readily occupy the whole interval, and be cemented to the old ice on every side; whence, the melted snow has no means of escape. Or, whatever be the means of its retention on the surface of the young field, whether by the adjunction of higher ice, the elevation of its border by the pressure of the surrounding ice, or the irregularity of its own surface, several inches of ice must be added to its thickness on the returning winter, by the conversion of the snow-water into solid ice. This process repeated for many successive years, or even ages, together with the enlargement of its under-side from the ocean, might be deemed sufficient to produce the most stupendous bodies of ice that have yet been discovered; at the same time that the ice thus formed, would doubtless correspond with the purity and transparency of that of fields in general.

Fields may sometimes have their origin in heavy close *packs*, which, being cemented together by the intervention of new ice, may become

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* That snow is deposited on the ice in high northern latitudes, is here allowed, because no field has yet been met with which did not support a considerable burthen of it.

one solid mass. In this way, are produced such fields, as exhibit a rugged, *hummocky* surface.

Fields commonly make their appearance about the month of June, though sometimes earlier :— they are frequently the resort of young whales; strong north and westerly winds expose them to the Greenlandmen, by driving off the loose ice. Some fields exhibit a perfect level plain, without a fissure or hummock, so clear indeed, that I imagine, upon one which I saw, a coach might be driven a hundred miles in a direct line, without any obstruction. Most commonly, however, the surface contains some hummocks, which somewhat relieve the uniformity of intense light, by a tinge of delicate green, in cavities where the light gains admittance in an oblique direction, by passing through a portion of ice.

The invariable tendency of fields to drift to the south-westward, even in calms, is the means of many being yearly destroyed. They have frequently been observed to advance a hundred miles in this direction, within the space of one month, notwithstanding the occurrence of winds from every quarter. On emerging from amidst the smaller ice, which before sheltered them, they are soon broken up by the swell, are partly dissolved, and partly converted into drift ice. The places of such, are supplied by others from the north. White bears here find an occasional habitation, and will travel many leagues from land

upon the fields. They have been repeatedly met with, not only upon these continuous sheets of ice, but on the ice of close packs, to the utmost extent to which ships have penetrated.

On the tremendous Concussions of Fields.

The occasional rapid motion of fields, with the strange effects produced on any opposing substance, exhibited by such immense bodies, is one of the most striking objects this country presents, and is certainly the most terrific. They not unfrequently acquire a rotatory movement, whereby their circumference attains a velocity of several miles *per* hour. A field, thus in motion, coming in contact with another at rest, or more especially with a contrary direction of movement, produces a dreadful shock. A body of more than ten thousand millions of tons in weight *, meeting with resistence, when in motion, the consequences may possibly be conceived ! The weaker field is crushed with an awful noise ; sometimes the destruc-

* A field of thirty nautical miles square surface, and thirteen feet in thickness, would weigh somewhat more than is here mentioned. Allowing it to displace the water in which it floats, to the depth of eleven feet, the weight would appear to be 10,182,857,142 nearly, in the proportion of a cubic foot of sea-water, to 64 lb.

tion is mutual: pieces of huge dimensions and weight, are not unfrequently piled upon the top, to the height of twenty or thirty feet, whilst doubtless a proportionate quantity is depressed beneath. The view of those stupendous effects in *safety*, exhibits a picture sublimely grand; but where there is danger of being overwhelmed, terror and dismay must be the predominant feelings. The whale-fishers at all times require unremitting vigilance to secure their safety, but scarcely in any situation, so much, as when navigating amidst those fields: in foggy weather, they are particularly dangerous, as their motions cannot then be distinctly observed. It may easily be imagined, that the strongest ship can no more withstand the shock of the contact of two fields, than a sheet of paper can stop a musket-ball. Numbers of vessels, since the establishment of the fishery, have been thus destroyed; some have been thrown upon the ice, some have had their hulls completely torn open, and others have been buried beneath the heaped fragments of the ice.

In the year 1804, I had a good opportunity of witnessing the effects produced by the lesser masses in motion. Passing between two fields of bay-ice, about a foot in thickness, they were observed rapidly to approach each other, and before our ship could pass the strait, they met with a velocity of three or four miles *per* hour: the one over-

laid the other, and presently covered many acres of surface. The ship proving an obstacle to the course of the ice, it squeezed up on both sides, shaking her in a dreadful manner, and producing a loud grinding, or lengthened acute tremulous noise, accordingly as the degree of pressure was diminished or increased, until it had risen as high as the deck. After about two hours, the velocity was diminished to a state of rest; and soon afterwards, the two sheets of ice receded from each other, nearly as rapidly as they before advanced. The ship, in this case, did not receive any injury, but had the ice been only half a foot thicker, she would probably have been wrecked.

In the month of May of the present year, (1813), I witnessed a more tremendous scene. Whilst navigating amidst the most ponderous ice which the Greenland seas present, in the prospect of making our escape from a state of *besetment*; our progress was unexpectedly arrested by an isthmus of ice, about a mile in breadth, formed by the coalition of the point of an immense *field* on the north, with that of an aggregation of *floes* on the south. To the north field, we moored the ship, in the hope of the ice separating in this place. I then quitted the ship, and travelled over the ice to the point of collision, to observe the state of the bar which now prevented our release. I immediately discovered, that the two points had but recently met; that already a prodigious mass

of rubbish had been squeezed upon the top, and that the motion had not abated. The fields continued to overlay each other with a majestic motion, producing a noise resembling that of complicated machinery, or distant thunder. The pressure was so immense, that numerous fissures were occasioned, and the ice repeatedly rent beneath my feet. In one of the fissures, I found the snow on the level to be three and a-half feet deep, and the ice upwards of twelve. In one place, hummocks had been thrown up to the height of twenty feet from the surface of the field, and at least twenty-five feet from the level of the water; they extended fifty or sixty yards in length, and fifteen in breadth, forming a mass of about two thousand tons in weight. The majestic unvaried movement of the ice,—the singular noise with which it was accompanied,—the tremendous power exerted,—and the wonderful effects produced, were calculated to excite sensations of novelty and grandeur, in the mind of even the most careless spectator!

Sometimes these motions of the ice may be accounted for. Fields are disturbed by currents,—the wind,—or the pressure of other ice against them. Though the set of the current be generally towards the south-west, yet it seems occasionally to vary: the wind forces all ice to leeward, with a velocity nearly in the inverse pro-

portion to its depth under water; light ice consequently drives faster than heavy ice, and loose ice than fields: loose ice meeting the side of a field in its course, becomes deflected, and its re-action causes a circular motion of the field. Fields may approximate each other, from three causes: *first*, If the lighter ice be to windward, it will, of necessity, be impelled towards the heavier: *secondly*, As the wind frequently commences blowing on the windward side of the ice, and continues several hours before it is felt a few miles distant to leeward, the field begins to drift, before the wind can produce any impression on ice, on its opposite side; and, *thirdly*, Which is not an uncommon case, by the two fields being impelled towards each other, by winds acting on each from opposite quarters.

The closing of heavy ice, encircling a quantity of bay-ice, causes it to run together with such force, that it overlaps wherever two sheets meet, until it sometimes attains the thickness of many feet. Drift-ice does not often coalesce with such a pressure, as to endanger any ship, which may happen to be *beset* in it: when, however, land opposes its drift, or the ship is a great distance immured amongst it, the pressure is sometimes alarming.

Icebergs.

The term *icebergs* has commonly been applied to those immense bodies of ice, situated on the

land, "filling the valleys between the high mountains," and generally exhibiting a square perpendicular front towards the sea. They recede backward inland to an extent never explored. MARTIN, CRANTZ, PHIPPS, and others, have described those wonders of nature, and all agree as to their manner of formation, in the congelation of the sleet and rains of summer, and of the accumulated snow, partly dissolved by the summer sun, which, on its decline, freezes to a transparent ice. They are as permanent as the rocks on which they rest: For although large portions may be frequently separated, yet the annual growth replaces the loss, and probably, on the whole, produces a perpetual increase. I have seen those styled the *Seven Icebergs*, situated in the valleys of the north-west cosat of Spitzbergen; their perpendicular front may be about 300 feet in height; the green colour, and glistening surface of which, form a pleasing variety in prospect, with the magnificence of the encompassing snow-clad mountains, which, as they recede from the eye, seem to "rise crag above crag," in endless perspective.

Large pieces may be separated from those icebergs in the summer season, when they are particularly fragile, by their ponderous overhanging masses, overcoming the force of cohesion; or otherwise, by the powerful expansion of the water, filling any excavation or deep-seated cavity, when its dimensions are enlarged by freezing, thereby

exerting a tremendous force, and bursting the whole asunder.

Pieces thus, or otherwise detached, are hurled into the sea with a dreadful crash; if they are received into deep water, they are liable to be drifted off the land, and, under the form of *ice-islands*, or *ice-mountains*, they likewise still retain their parent name of *icebergs*. I much question, however, if all the floating *bergs* seen in the seas west of Old Greenland, thus derive their origin; their number is so great, and their dimensions so immense.

Magnitude of Icebergs.

If all the floating islands of ice thus proceed from disruptions of the icebergs generated on the land, How is it that so few are met with in Greenland, and those comparatively so diminutive, whilst Baffin's Bay affords them so plentifully, and of such amazing size? The largest I ever saw in Greenland, was about a thousand yards in circumference, nearly square, of a regular flat surface, twenty feet above the level of the sea, and as it was composed of the most dense kind of ice, it must have been 150 or 160 feet in thickness, and in weight about two millions of tons. But masses have been repeatedly seen in Davis' Straits, near two miles in length, and one-third as broad, whose rugged mountainous summits were reared with various spires to the height of more than a hundred feet, whilst their base must have

reached to the depth of a hundred and fifty *yards*, beneath the surface of the sea. Others, again, have been observed, possessing an even surface, of five or six square miles in area, elevated thirty yards above the sea, and fairly run aground in water of ninety or a hundred fathoms in depth; the weight of which, must have been upwards of two thousand millions of tons*!

Icebergs may arise in sheltered bays of the Land.

Spitzbergen is possessed of every character which is supposed to be necessary for the formation of the largest icebergs; high mountains, deep extensive valleys, intense frost, and occasional thaws; yet here a *berg* is very rarely met with, and the largest I ever heard of, was not to be compared with the productions of Baffin's Bay. Icebergs, I therefore conclude, may have their principal origin in the deep sheltered narrow bays, with which *Old* or West Greenland abounds. In this respect, it possesses a decided advantage over Spitzbergen, since, on the West side, the coast now alone visited, few sheltered spots occur; at least those situations, the most protected from the influences of

* Suppose the iceberg 3 miles (English statute) long, by 2 broad, that is 15,840 by 10,560 feet surface, and 500 feet deep under water, it would displace 83,635,200,000 cubic feet of sea-water; and as a cubic foot of Greenland sea-water weighs 63 lb. 15 oz. 4 dr., or 64 lb. nearly, the weight of the mass would appear to be about 2,389,577,142 tons.

the wind and prevailing currents, are found annually to disembogue themselves of their ice. On the eastern coast, if we may rely on the charts, and credit the affirmations of the Dutch, many more suitable spots are offered, wherein ice may be increased for ages; the most prevailing winds, and the common set of the current on these shores, having no tendency to dislodge it, until its enormous growth has carried it beyond the limits of security and undisturbed rest. And from this Eastern coast, it is, (which is favourable to the supposition,) that most of the icebergs which have been seen, seem to have drifted,—they being mostly met with in the vicinity of Cherry Island, or between it and the southern Cape of Spitzbergen, where the course of the current is supposed to be from the north-east towards the south-west. The ice of *bergs* invariably producing pure fresh-water, when dissolved, is no argument against the majority having their origin amidst sea-water; for fields, which, from their flat surface, and large extent, must have their rise on the bosom of the ocean, commonly afford a solution equally fresh.

Icebergs generated at a distance from any known land.

Müller relates a circumstance, which intimates, That some icebergs have their origin in the wide expanse of the ocean. He informs us, that in the year 1714, one Markoff, a Cossack, with some

other persons, were sent to explore the ocean north of Russia, by order of the Russian Government; but being foiled in his object, by the immense aggregation of drift-ice, he conceived the design of trying during the winter season to travel over the then more compact ice. Accordingly, he prepared several of the country sledges, drawn by dogs, and, accompanied by eight persons, he set out on the 15th of March (O. S.) from the mouth of the Yani, on the coast of Siberia, in latitude 71° N. and longitude about 132° E. He proceeded for seven days northward, until he reached the 77th or 78th degree of north latitude, when his progress was impeded by ice elevated into prodigious mountains. From the top of these, he could see nothing but mountainous ice to the northward; at the same time falling short of provisions for his dogs, he returned with difficulty: several of his dogs died for want, and were given to the rest for their support. On the 3d of April he reached the Siberian shore, after an absence of nineteen days, during which he travelled 800 miles.

Here, therefore, is a fact of a continent, if we may so speak, of mountainous ice existing, and probably constantly increasing in the ocean, at a distance of between three and four hundred miles from any known land: indeed, it must be so completely sheltered by the exterior drift or field ice in every direction, that there seems every facility afforded for its growth, that a sheltered bay in the land could supply.

On the growth of Icebergs formed on the sea.

As the difference in the appearance of the ice of fields, and of that formed in places within our observation, seems to require the deposition of moisture from the atmosphere for explaining the phenomenon ; so, the similarity of the ice of bergs with that of fields, (whether generated in bays of the land, or in regions nearer the Pole), is a reason for admitting the operation of the same causes in their production. If we can conceive, from the before-mentioned process of the enlargement of fields by the addition of the annually deposited humidity, that a few years are sufficient for the production of considerable fields of ice, What must be the effect of fifty or sixty centuries affording an annual increase in undisturbed security?

If, therefore, we add to the precipitations from the atmosphere, the stores supplied by the sea, and allow the combination of these two by the agency of an intense frost, and conceive also a state of quiescence, for the operation of these causes, secured for ages, the question of the mode of production of the most enormous ice mountains seems to have a sufficient solution.

Loose icebergs, it has been observed, are but sparingly disseminated in the Greenland Seas, but in Davis' Straits they abound in astonishing profusion. Setting constantly towards the south, they are scattered abroad to an amazing extent. The

Banks of Newfoundland are occasionally crowded with these wonderful productions of the frigid zone. They have been met with as far south as the latitude of 40° N., a distance of at least 2100 miles from their source.

Icebergs numerous in the Antarctic Zone.

The indefatigable Captain Cook, when exploring the regions beyond the antarctic circle, met with icebergs on every course, in great abundance, as well as of vast size; many, according to Forster, were one or two miles in extent, and upwards of a hundred feet above the water, and might be supposed to be sunk to ten times that depth. On the 26th of December 1773, they counted 186 icebergs from the mast-head, whereof none were less than the hull of a ship.

Icebergs useful to the Whale-Fishers.

Icebergs, though often dangerous neighbours, occasionally prove useful auxiliaries to the whale-fishers. Their situation, in a smooth sea, is very little affected by the wind: under the strongest gale, they are not perceptibly moved; but, on the contrary, have the appearance of advancing to windward, from every other decription of ice moving so rapidly past them, on account of its finding less resistance from the water, in proportion as its depth beneath the surface is diminished. From the iceberg's firmness, it often affords

a stable mooring to a ship in strong adverse winds, or when a state of rest is required for the performance of the different operations attendant on a successful fishery. The fisher likewise avails himself of this quiescent property, when his ship is incommoded or rendered unmanageable by the accumulation of drift-ice around, when his object is to gain a windward situation more open. He gets under the lea of the ice-berg,—the loose ice soon forces past the berg,—the ship remains nearly stationary,—and the wished-for effect seldom fails to result. Mooring to *lofty* icebergs, is attended with considerable danger: being sometimes finely balanced, they are apt to be overturned; and whilst floating in a tide-way, should their base be arrested by the ground, their detrusion necessarily follows, attended with a thundering noise, and the crushing of every object they encounter in their descent: thus have vessels been often staved, and sometimes wrecked, by the fall of their icy mooring. Men and boats are a weaker prey,—the vast waves alone occasioned by such events, at once overwhelming every smaller object, within a considerable distance of the rolling mountain.

Fragility of Icebergs.

All pure ice becomes exceedingly fragile towards the close of the whale-fishing season,

when the temperate air thaws its surface. Bergs, on being struck by an axe, for the purpose of placing a mooring anchor, have been known to rend asunder and precipitate the careless seamen into the yawning chasm, whilst occasionally the masses are hurled apart, and fall in contrary directions with a prodigious crush, burying boats and men in one common ruin. The awful effect produced by a solid mass many thousands of tons in weight, changing its situation with the velocity of a falling body, whereby its aspiring summit is in a moment buried in the ocean, can be more easily imagined than described!

If the blow with any edge-tool on brittle ice does not sever the mass, still it is often succeeded by a crackling noise, proving the mass to be ready to burst from the action of an internal expansion; in this way, sometimes deep chasms are formed, similar to those occurring in the Glaciers of the Alps.

It is common, when ships moor to icebergs, to lie as remote from the danger as their ropes will allow, and yet accidents sometimes happen, though the ship ride at a distance of a hundred yards from the ice. Thus, *calves* rising up with a velocity nearly equal to that of the descent of a falling berg, have produced destructive effects. In the year 1812, whilst the Thomas of Hull, Captain Taylor, lay moored to an iceberg in Davis' Straits, a *calf* was detached from beneath, and

rose with such tremendous force, that the keel of the ship was lifted even with the water at the bow, whilst the stern was nearly immersed beneath the surface. Fortunately the ship was not materially damaged.

From the deep pools of water formed in the summer season, on the depressed surface of some bergs, the ships navigating where they abound, are presented with opportunities for watering with the greatest ease and dispatch. For this purpose, casks are landed upon the lower bergs, whilst, from the higher, the water is conveyed by means of a *hose** into casks placed in the boats, at the side of the ice, or even upon the deck of the ship.

Navigating amongst icebergs in the gloom of night, has sometimes been attended with fatal consequences. Occurring far from land, and in unexpected situations, the danger would be extreme, were they not providentially rendered visible by their natural effulgence, which enables the mariner to distinguish them at some distance, even in the darkest night, or during the prevalence of the densest fog.

* A *hose* is a long cylinder of canvass, used solely for the purpose of conveying water from one place to another.

Abstract of the remarks on the formation of the Polar Ice.

From what has been advanced in the preceding pages, on the mode and place of formation of the ice, occurring in the seas intermediate between East Greenland or Spitzbergen, and West or *Old* Greenland, the following conclusions seem naturally to result, and which will partly apply to the formation of the ice in other places of the polar circle:

I. *Drift ice.*—That the *light* packed or drift ice is the annual product of the bays of Spitzbergen, and of the interstices in the body of older ice; and, that it is wholly derived from the water of the ocean.

That the *heavy* packed or drift ice generally arises from the disruption of fields.

II. *Icebergs.*—That some ice mountains or icebergs are derived from the icebergs generated on the land between the mountains of the sea coast, and are consequently, the product of snow or rain water.

That a more considerable portion may probably be formed in the deep sheltered bays abounding on the east coast of Spitzbergen. These have their bed in the waters of the ocean, and are part-

ly the product of sea-water, and partly that of snow and rain water. And it is highly probable,

That a continent of ice mountains may exist in regions near the Pole, yet unexplored, the nucleus of which may be as ancient as the earth itself, and its increase derived from the sea and atmosphere combined.

III. *Fields.*—That some fields arise from the cementation, by the agency of frost, of the pieces of a closely aggregated pack, which may have consisted of light or heavy ice; and, consequently, which may have been wholly derived from the ocean, or from the sea and atmosphere combined.

That the most considerable masses are generated in openings of the far northern ice, produced by the constant recession towards the south of that body lying near the coasts of Spitzbergen, ; and, that such fields are at first derived from the ocean, but are indebted for a considerable portion of superstructure, to the annual addition of the whole, or part of their burthen of snow. And,

IV. As to the *ice in general.*—That however dependant the ice may have been on the land, from the time of its first appearance, to its gaining an ascendancy over the waves of the ocean, sufficient to resist their utmost ravages, and to ar-

test the progress of maritime discovery, at a distance of perhaps from six hundred to a thousand miles from the Pole, it is now evident, That the the proximity of land is not essential, either for its existence, its formation, or its increase.

On the situation of the Polar Ice, and the effects produced on it by the change of seasons.

The mass of ice lying between *Old* Greenland on the west, and the Russian portion of Europe on the east, though varying considerably in particulars, yet has a general outline strikingly uniform.

On the east coast of West Greenland, a remarkable alteration has, however, taken place. That part extending from the parallel of Iceland to Staten-Hook, was, before the fifteenth century, free of ice, and could always be approached in the summer season, without hinderance. After a considerable trade had been carried on between Iceland and the Main for upwards of 400 years, singular, as it may appear, of a sudden the polar ice extended its usual limits, launched down by the land to the Southern Cape, and so completely barricadoed the whole of the eastern coast, that it has not since been accessible. The fate of the wretched inhabitants is unknown ; but they are generally supposed to have perished from the want

of their usual supplies, or from the increased coldness of their atmosphere.

In various countries, changes of climate to a certain extent, have occurred, within the limits of historical record; these changes have been commonly for the better, and have been considered as the effects of human industry, in draining marshes and lakes, felling woods, and cultivating the earth: but here is an occurrence, the reverse of common experience; and concerning its causes, I am not prepared to hazard any conjecture.

This icy barrier, at present, with each recurring spring, exhibits the following general outline. After doubling the southern promontory of Greenland, it advances in a north-eastern direction along the east coast, enveloping Iceland as it proceeds, until it reaches John Mayne's Island *. Passing this island on the north-west, but frequently enclosing it likewise, it then trends a little more to the eastward, and intersects the meridian of London in the 71st or 72d degree of latitude. Having reached the longitude of 6, 8, or perhaps 10 degrees east, in the 73d or 74th degree of north latitude, it suddenly stretches to the north, sometimes proceeding on a meridian to the latitude of 80°, at others forming a deep si-

* Latitude 71° N.; longitude about 5½° W.

nuosity, extending two or three degrees to the northward, and then south-easterly to Cherry Island;—which having passed, it assumes a direct course a little south of east, until it forms a junction with the Siberian or Nova Zemblan coast.

That remarkable promontory, formed by the sudden stretch of the ice to the north, constitutes the line of separation between the east or whale-fishing, and west or *sealing* ice of the fishers: And the deep bay lying to the east of this point, invariably forms the only pervious track for proceeding to fishing latitudes northward. When the ice at the extremity of this bay occurs so strong and compact as to prevent the approach to the shores of Spitzbergen, and the advance northward beyond the latitude of 75° or 76°, it is said to be a *close season*; and, on the contrary, it is called an *open season*, when an uninterrupted navigation extends along the western coast of Spitzbergen to Hackluyt's Headland. In an open season, therefore, a large channel of water lies between the land and the ice, from 20 to 50 leagues in breadth, extending to the latitude of 79° or 80°, and gradually approximating the coast, until it at length effects a coalition with the north-western extremity, by a semi-circular head. When the continuity of the mass of ice, intervening between West Greenland and Nova Zembla, is thus interrupted in an open season, the ice again makes its

appearance on the south of Spitzbergen, proceeding from thence direct to Cherry Island, and then eastward as before.

Such is the general appearance of the margin or outline of the polar ice, which holds, with merely partial changes, for many successive seasons. This outline, however, is necessarily more or less affected by storms and currents: their more than ordinary prevalence in any one direction, must cause some variety of aspect in particular places, which becomes more especially apparent in the vicinity of land, where its coasts afford marks by which to estimate the advance and retreat of the ice.

The line formed by the exterior of the ice, is variously indented, and very rarely appears direct or uniform. Open bays or arms occur, from a few fathoms, to several miles in length. None of them, however have any determinate form or place, except the "*Whale-fisher's Bight*," or great bay before described, in which the Greenlandmen ever seek a passage to the fishing stations.

The place where whales occur in the greatest abundance, is generally found to be in the 78th or 79th degree of north latitude, though from the 72d to the 81st degree they have been met with. These singular animals, which, on account of their prodigious bulk and strength, might be thought entitled to reign supreme in the ocean,

are harmless and timid. They seem to prefer those situations which afford them the most secure retreats. Among the ice, they have an occasional shelter; but so far as it is permeable, the security is rather apparent than real. That they are conscious of its affording them shelter, we can readily perceive, from observing that the course of their flight when scared or wounded, is generally towards the nearest or most compact ice. The place of their retreat, however, is regulated by various circumstances; it may sometimes depend on the quality and quantity of food occurring, the disposition of the ice, or exemption from enemies. At one time, their favourite haunt is amidst the huge and extended masses of the field ice; at another, in the open seas adjacent. Sometimes the majority of the whales inhabiting those seas, seem collected within a small and single circuit; at others, they are scattered in various hordes, and numerous single individuals, over an amazing extent of surface. To discover and reach the haunts of the whale, is an object of the first consideration in the fishery, and occasionally the most difficult and laborious to accomplish. In *close seasons*, though the ice joins the south of Spitzbergen, and thereby forms a barrier against the fishing-stations, yet this barrier is often of a limited extent, and terminates on the coasts of Spitzbergen in an open space, either forming, or leading to, the retreat of the

whales. Such space is sometimes frozen over until the middle or end of the month of May, but not unfrequently free of ice. The *barrier* here opposed to the fisher, usually consists of a mass of ice from 20 to 30 or 40 leagues across in the shortest diameter. It is generally composed of packed ice, and often cemented into a continuous *field* by the interference of *bay* ice, which incredibly augments the difficulty of navigating among it.

As the time that can be devoted to the whale-fishery, is, by the nature of the climate, limited to three or four months * in the year, it is of importance to pass this *barrier* of ice as early as possible in the season. The fisher here avails himself of every power within his command. The sails are expanded in favourable winds, and withdrawn in contrary breezes. The ship is urged forward amongst the *drift* ice through the force of the wind, assisted by ropes and saws. Whenever a *vein of water*, as it is called, appears

* The fishery is prevented in the winter season, by the intensity of the frost,—the deficiency of light,—and the impracticability of reaching the usual fishing stations at that season; and these obstacles are not considered sufficiently removed until the month of April. The other limit is occasioned by the prevalence of dense fogs, and the disappearance of the whales, which circumstances, generally close the fishery by the end of June or beginning of July.

in the required direction, it is if possible attained. It always affords a temporary relief, and sometimes a permanent release, by extending itself through intricate mazes, amidst ice of various descriptions, until at length it opens into the desired place, void of obstruction, and the retreat of the whales.

The formidable barrier before described, is regularly encountered on the first arrival of Greenland ships in the month of April, but is generally removed by natural means as the season advances. However extensive, huge and compact it may be, it is usually found separated from the land, and divided asunder by the close of the month of June; and hence it is, that however difficult and laborious may have been the ingress into the fishing country, the egress is commonly effected without particular inconvenience.

That the ice should envelope the whole coasts of Spitzbergen in the winter season, and expose the western shore about the month of June; that the ocean should be almost annually navigable on the meridians of 5° to 10° E., to the 80th degree of north latitude, whilst the ice in every other part of the world, can rarely be penetrated beyond the 74th degree, are facts highly curious, and certainly worthy of consideration.

On the recession of the ice from the west side of the land, a lane of water must be left from one extremity to the other; while to the south of

Point Look-Out, a parallel motion of the ice, leaves no opening or evidence of its change of place; for here, the ice meeting with no obstruction to cause it to divide, moves on in a solid body, retained firm and unbroken by the tenacious *solder* of the interjacent *bay* ice.

In the month of May, the severity of the frost relaxes, and the temperature occasionally approaches within a few degrees of the freezing point: the brine then exerts its liquefying energy, and destroys the tenacity of the bay ice, makes inroads in its parts by enlarging its pores into holes, diminishes its thickness, and, in the language of the whale-fisher, completely *rots* it. The packed drift ice is then loosed; it submits to the laws of detached floating bodies, and obeys the slightest impulses of the winds or currents. The heavier having more stability than the lighter, an apparent difference of movement obtains among the pieces. Holes and lanes of water are formed, which allow the entrance and progress of the ships, without that stubborn resistance offered earlier in the spring of the year.

Bay ice is sometimes serviceable to the whale-fishers, in preserving them from the brunt of the heavy ice, by embedding their ships, and occasioning an equable pressure on every part of the vessel: but, in other respects, it is the greatest pest they meet with in all their labours: it is troublesome in the fishery, and in the progress to

the fishing ground; it is often the means of *be-setment*, as it is called, and thence the primary cause of every other calamity. Heavy ice, many feet in thickness, and in detached pieces of from 50 to 100 tons weight each, though crowded together in the form of a pack, may be penetrated, in a favourable gale, with tolerable dispatch; whilst a sheet of bay ice, of a few inches only in thickness, with the same advantage of wind, will often arrest the progress of the ship, and render her in a few minutes immovable. If this ice be too strong to be broken by the weight of a boat, recourse must be had to sawing, an operation slow and laborious in the extreme.

When the warmth of the season has rotted the bay ice, the passage to the northward can generally be accomplished with a very great saving of labour. Therefore it was, the older fishers seldom or never used to attempt it before the 10th of May, and foreigners are in general late. Sometimes late arrivals are otherwise beneficial; since it frequently happens, in *close seasons*, that ships entering the ice about the middle of May, obtain an advantage over those preceding them, by gaining a situation more eligible, on account of its nearness to the land. Their predecessors, meanwhile, are drifted off to the westward with the ice, and cannot recover their easting; for, they are encompassed with a large quantity of ice, and have a greater distance to go than when they first

entered, and on a course precisely in opposition to the direction of the most prevailing winds. Hence it appears, that it would be economical and beneficial to sail so late, as not to reach the *country* before the middle of May, or to persevere on the seal catching stations until that time. There are, however, some weighty objections to this method. *Open seasons* occasionally occur, and great progress may sometimes be made in the fishery before that time. Also, although the majority of the ships do not commonly succeed in passing the barrier in *close seasons* before a certain period, yet some individuals, by superior exertion, perseverance, ability, or good fortune, accomplish the end considerably before the rest, and thereby gain a superiority in the fishery, not to be attained by later arrivals. A week or fortnight's solitary fishing, under these circumstances, has frequently gained half a cargo,—an advantage of the most interesting importance, in a voyage of so limited duration, and where the success is *supposed* to depend so considerably upon *chance*.

That there is something resembling what is called *chance* or *luck* in the fishery, cannot be disputed; but that the fishery is altogether a chain of casualties, is as false, as it is derogatory to the credit of the persons employed in the enterprize. For a person with a die to throw the highest point once in six times, is what might be expected from *chance*; but for him to throw the highest

point many times in succession, would afford a presumptive proof, that he employed some art in casting the die. So it is with the fishery. The most skilful, from adventitious and unavoidable circumstances, may occasionally fail, and the unskilful may be successful; but mark the average of a number of years, (that is where the means are equal,) and a tolerable estimate may be formed, of the adventurer's fitness for his undertaking.

The change which takes place in the ice amidst which the whale-fisher pursues his object, is, towards the close of the *season*, indeed astonishing. For, not only does it separate into its original individual portions,—not only does it retreat in a body from the western coast of Spitzbergen, but in general, that whole barrier of ice which encloses the fishing site in the spring, which costs the fisher immense labour and anxiety to penetrate, after retarding his advance towards the north, and progress in the fishery, for the space of several weeks,—spontaneously divides in the midst about the month of June, and on the return of the ships is not at all to be seen! Then is the sea rendered freely navigable from the very haunts of the whales, to the expanse of the Northern and Atlantic Oceans.

This quality of the ice, is of the first importance to the navigator. It is this known property which gives him confidence in his advance, and en-

ables him to persevere without restraint, calculating on an easy return. As one-half of the fishing season is often spent in the ingress, were the regress as arduous, the sailing would occupy the whole time: besides, the return would be rendered doubly hazardous by the prevalence of the summer fogs, which are thick in the extreme, and sometimes continue for days together, without any relaxation of density.

Were the barrier of ice not passable, the haunts of the whales could not be attained; and were the regress not aided by natural facilities, every attempt to prosecute the whale-fishery with effect, would be attended with imminent danger; I may say, with almost certain destruction.

On the Properties, peculiar Movements, and Drifting of the Ice.

1. The ice always has a tendency to separate during calms. This property holds, both with regard to field and drift ice, and seems to arise from a repelling tendency between the individual masses. Hence it is, that when the heavy ice is released from its confinement by the dissolution of the intruding bay ice, a calm generally spreads its pieces abroad, and allows a free passage for ships, which before could not be urged forward with all the assistance to be derived from the wind combined with every effort of art. From

the same cause, it is, that ice, which with strong winds is formed into compact *streams* or *patches*, and allows a safe and commodious passage amidst these large aggregations,—on the occurrence of one or two days of calm weather, will be disseminated into every opening, and seem to fill every space, allowing only a troublesome and sinuous navigation. In this case, the dispersion is so general, that scarcely any two pieces can be said to touch each other.

Openings in *packs*, and amidst fields, frequently break out or disappear without any apparent cause. It is often of importance to the fisher to determine, whether any space be in the course of diminishing or enlarging. The freezing of the water generally affords an intimation of its coarcting, as it rarely occurs on the extension of the bounding ice. The birds likewise instinctively leave the closing spaces, and fly in search of such as are in the course of opening.

2. The amazing changes which take place in the most compact ice, are often unaccountable. They astonish even those who are accustomed to their occurrence. Thus, ships immovably fixed with regard to the ice, have been known to perform a complete revolution in a few hours; and two ships *beset* * a few furlongs apart, within the

* The word *beset*, is by the whale-fishers invariably used to indicate the state of a ship when fixed immovably by the ice.

most compact pack, have sometimes been separated to the distance of several leagues within the space of two or three days, notwithstanding the apparent continuity of the pack remained unbroken!

On the 7th of May 1798, the Dundee of London, (then commanded by my Father,) while forcing to the northward on the most eligible course, was suddenly stopped by a shift of wind, and enveloped by the ice at a very short distance from the land. The Volunteer of Whitby, and three other ships, were likewise arrested, a little way from the Dundee. During the day, three Russian convicts visited them, coming over the ice from the nearest shore; but as none of the crew could speak their language, they were prevented from deriving any information from them.

The next day, a heavy gale of wind prevailed from the north-west; the frost was intense, and much snow fell. The pressure of the ice was very severe; insomuch, that their *iron-tiller* was broken, the ship lifted above two feet, and forced within a mile and a half of the land. All the bay ice was squeezed upon the top of the heavy ice, and the whole was rendered so compact, that they could not find a hole sufficient to admit a *lead*, for the purpose of ascertaining the depth of the water. They got their provisions upon deck, considering the ship in great danger.

On the 9th, they were in latitude 77° 38′ N. The intensity of the pressure was not diminished. The Volunteer lay beset three miles off, under a like dangerous pressure.

In my Father's Journal of the 12th, appear the following remarks: "*N. B.*—I cannot, from the top-gallant-mast-head, see over the flat of ice to the north-east, into which the ship is frozen; and yet in fifty hours it has revolved from the south-south-west, westerly to north, and carried the ship with a semi-circular motion 15 or 20 leagues. On the 10th instant, we were within 1½ miles of the land, whereas our distance is now 10 leagues, and our advance to the northward even greater. The Volunteer has drifted out of sight in the south-west quarter."

On the 15th, after labouring eight and forty hours without rest, they escaped into a place of safety.

3. When speaking of the formation of fields, I had occasion to remark, that the polar ice has a constant tendency to drift to the south-westward; with regard to which, it may be observed, that in situations near the western coast of Spitzbergen, this tendency is seldom observed, but rather the contrary. This may probably result from the effects of the tide, eddies, or peculiar pressures. Its universal prevalence, however, at a distance from the land, though with some slight variations, may be illustrated by numerous facts of almost

annual occurrence. A few striking incidents shall suffice.

From a narrative of the loss of several of the Dutch Greenland fleet in the year 1777, we learn, that the ship Wilhelmina was moored to a field of ice on the 22d of June, in the usual fishing-station, along with a large fleet of other whalers. On the 25th, the Wilhelmina was closely *beset*. The crew were obliged to work incessantly for eight days, in sawing a dock in the field, wherein the ship was at that time preserved.

On the 25th of July, the ice slacked, and the ship was towed to the eastward, during four days laborious rowing with the boats. At the extremity of the opening, they joined four ships, and all of them were soon again beset by the ice. Shortly afterwards, they were drifted within sight of the coast of *Old* Greenland, in about $75\frac{1}{2}°$ of north latitude. On the 15th of August, nine sail were collected together; and about the 20th, after sustaining a dreadful storm, and an immense pressure of the ice, which accumulated around them twenty or thirty feet high,—two of the ships were wrecked. Two more were wrecked four or five days afterwards, together with two others at a distance from them. On the 24th, Iceland was in sight; some of the ice was in motion, and two ships seemed to escape. Another was lost on the 7th of September; and, on the 13th, the Wilhelmina was crushed to pieces by the fall of

an enormous mass of ice, which was so unexpected, that those of the crew who were in bed, had scarcely time to escape on the ice, half naked as they were.

One ship now alone remained, to which the crews of four, and the surviving part of the crew of a fifth, (that was wrecked on the 30th September), repaired. In the beginning of October, they had drifted to the latitude of 64° ; and, on the 11th, the last ship was overwhelmed by the ice and sunk. Thus, between three and four hundred men were driven to the ice, and exposed to the inclemency of the weather, almost destitute of food and raiment.

On the 30th of October, the miserable sufferers divided: The greater part betook themselves to the Continent, whilst the rest remained on a field of ice, until they drifted near to Staten Hook, and then followed the example of their comrades. About 140 of the men reached the Danish settlements on the West Coast of Greenland; the remainder, consisting of about 200, perished.

Thus, it appears, that the ship which survived to the latest period, drifted with the ice in a south-westerly direction from the usual fishing-stations, (probably in 78° to 80° of north latitude), to the latitude of about 62° ; at the same time, from longitude a few degrees easterly, to that of more than 30° west; and, that the ice

still continued to advance along the land to the southward.

In the year 1803, the Henrietta of Whitby, while prosecuting the whale-fishery, was, by a southerly storm, entangled among the ice in the latitude of 80° north, and longitude of 6° east; and afterwards accompanied it in its drift to the south-westward, at the daily rate of from ten to fifteen miles. They saw several bears; and at one time they conceived that the land of *West* Greenland was within sight. The ice pressed dreadfully around them, and accumulated in amazing heaps; but providentially, the ship always escaped the heaviest crushes. After a state of complete inertion during seven weeks, the ice began to slack; when, with vigilant and laborious measures, they were enabled to make their escape, in latitude about 73½° north, and longitude 9° west.

When treating of the pressure of fields, I slightly alluded to a circumstance which occurred within my own observation on my last voyage to Greenland (1814). While it affords a suitable illustration of the tremendous effects produced by the collision of those prodigious sheets of ice, it is no less applicable to the subject in hand; I shall therefore give a sketch of the whole occurrence.

In the beginning of May, we entered with the ship Esk of Whitby, a spacious opening of

the ice, to a distance of ten or twelve leagues from the exterior, wherein we were tempted to stay, from the appearance of a great number of whales. On the 9th of May, the weather calmed, the frost was severe, and the ship was soon fixed in *young* ice. At the same time, the external sheets of ice on the north-east wheeled to the south, formed a junction with the ice south-east from us, and completely enclosed us. Until the 16th, we lay immovable; a break of the bay ice then appeared about half a-mile from us, to attain which, we laboured with energy, and in eight hours had made a passage for the ship. On the 18th, we pursued the same opening to its eastern extremity, and endeavoured, but without success, to force through a narrow neck of ice, into another opening leading further in the same direction. On the 20th, in accomplishing this object, we endured a heavy pressure of the bay ice, which shook the ship in an alarming manner. The next day, we made a small advance; and on the 22d, after a fatiguing effort in passing through the midst of an aggregation of floes, against the wind, we obtained a channel which led us several miles to the south-eastward. On the 23d, we lay at rest together with four other ships. The day following, having sawn a place for the ship in a thin floe, we forced forward between two large masses, where bay ice unconsolidated had been compressed, until it had become 10 or 12 feet

thick. We were assisted by about a hundred men from the accompanying ships, which followed close in our rear; and after applying all our mechanical powers during eight or nine hours, we passed the strait of about a furlong in length, and immediately the ice collapsed and rivetted the ships of our companions to the spot. As they declined our proffered assistance, (which indeed, at this time, would have been quite unavailing), we determined to improve the advantage we had acquired, by proceeding to the utmost limits of the opening. Accordingly, we advanced, on various winding courses, amidst bay ice and fields, in narrow obscure passages, a distance of several miles. We then discovered a continuation of the navigation, which, although contracted to the space of a few yards, in a channel extending near a mile, between two immense sheets of ice, we determined to attempt to pass on. The prospect was indeed appalling; but, perceiving indications of the enlargement of the passage, rather than the contrary, we advanced under a press of sail, driving aside some disengaged lumps of ice that opposed us, and shortly accomplished our wishes in safety. Here, an enlivening prospect presented itself: to the extreme limits of the horizon, no interruption was visible. We made a predetermined signal to the ships we had left, indicative of our views. In two hours, however, our sanguine expectations of an immediate release,

received a check, for we then met with fields in the act of collapsing and completely barring our progress. As the distance across was scarcely a mile, and the sea to appearance clear beyond it, the interruption was most tantalizing. We waited at the point of union, in the hope of the separation of the two fields; and on the morning of the 26th of May, our anxiety was happily relieved, by the wished-for division of the ice. The ship, propelled by a brisk wind, darted through the strait, and entered a sea, which we considered the termination of our difficulties. After steering three hours to the south-eastward, as directed by the northern ice, we were concerned to discover, that our conclusions had been premature. An immense *pack* opened on our view, stretching directly across our track. There was no alternative, but forcing through it: we therefore pushed forward into the least connected part. By availing ourselves of every advantage in sailing, where sailing was practicable, and *boring* * or drifting, where the pieces of ice were too compact, we at length reached the leeward part of a

* *Boring*, is the operation of forcing a ship through crowded ice by the agency of the wind on the sails. The impetus of the ship is studiously directed against the opposing pieces, and a passage thereby effected. It can be performed only with favourable winds.

narrow channel, in which we had to ply a considerable distance against the wind. In performing this, the wind, which had hitherto blown a brisk breeze from the north, was increased to a strong gale: the ship was placed in such a critical situation, that we could not for above an hour accomplish any reduction of the sails, and she was thus alarmingly oppressed: while I was personally engaged performing the duty of a pilot from the top-mast-head, the agitation and bending of the mast was so uncommon, that I was seriously alarmed for its stability. At length we were enabled to reef our sails, and for a while proceeded with less danger. We continued to manœuvre among the ice, according as its separation was most considerable. Our direction was now east, then north for several hours, then easterly 10 or 15 miles;—when, after eighteen hours of the most difficult, and occasionally hazardous sailing, in which the ship received some hard blows from the ice; after pursuing a devious course nearly ninety miles, and accomplishing a distance on a direct north-east course of about forty miles; we found ourselves at the very margin of the sea, separated only by a narrow *sea stream* *. The waves were

* Drift ice exposed to the swells of the sea, is generally compacted into the form of an extensive *stream* of ice, which, owing to its situation, acquires the name of a *sea stream* of ice.

so great without, and the wind so violent, that we dared not to hazard an attempt to force through this remaining obstacle. After waiting about thirty hours, on the morning of the 28th of May, the weather cleared, and the wind abated. The sea stream, which, the preceding day, did not exceed two hundred yards in breadth, was generally augmented to upwards of a mile broad. One place alone was visible, where the breadth was less considerable ; to that we directed our course, forced the ship into it, and by prompt and vigorous exertions, were enabled to surmount every difficulty, and accomplish our final escape into the free ocean.

I have been thus minute in the relation of the progress of our extrication from an alarming, though not very uncommon, state of *besetment*, both for the purpose of giving a faint idea of the difficulties and dangers which those engaged in the whale-fishery have occasionally to encounter, and also more particularly to shew, the extraordinary manner in which ships are imperceptibly immured amidst the ice, by the regularity of its drift to the south-westward.

From this narrative, it will appear, that, notwithstanding we only penetrated 25 or 30 miles on our ingress, and among ice most widely disposed ; yet, before our regress was accomplished, we had passed on a direct course a distance of 35 or 40 leagues, whereof one-half was in con-

tracted channels, amidst compact and formidable ice. And, further, that in less than a fortnight, while at rest with regard to the ice, our drift, as ascertained by astronomical observations, had been 60 or 70 miles to the south, and a distance equally as great to the west.

Effects of the Ice on the Sea and the Atmosphere.

The profusion of ice in the polar regions, produces peculiar and marked effects on the surrounding elements. The sea, in consequence, exhibits some interesting characters, and the atmosphere, some striking phenomena. Of these, the power the ice exerts on the wind,—on aqueous vapour,—on the colour of the sky,—and on the temperature of the air, are the most prominent; and of those, accordingly as the ice or swell has the ascendancy, the results are varied and remarkable.

1. When the wind blows forcibly across a solid pack or field of ice, its power is much diminished ere it traverses many miles: Insomuch, that a storm will frequently blow for several hours on one side of a field, before it be perceptible on the other; and, while a storm prevails in open water, ships beset within sight, will not experience one-half of its severity.

It is not uncommon for the ice to produce the effect of repulsing and balancing an assailing wind.

Thus, when a severe storm blows from the sea, directly towards the main body of ice, an opposite current will sometimes prevail on the borders of the ice; and such conflicting winds have been observed to counterpoise each other, a few furlongs distant from the ice, for several hours: the violence of the one, being, as it were, subdued by the frigorific repulsion and lesser force of the other. The effect resulting, is singular and manifest.

2. The moist and temperate gale from the southward, becomes chilled on commixture with the northern breeze, and discharges its surplus humidity in the thickest snow*. As the quantity of the snow, depends considerably on the difference of temperature of the two assimilating streams of air, it follows, that the largest proportion must be precipitated on the exterior of the main body of ice, where the contrast of temperature is the greatest: and since that contrast must be gradually diminished, as the air passes over the gelid surface of the ice, much of its superabundant moisture must generally be discharged before it reaches the interior. Hence, we can account for

* It is almost needless to say, that the foundation of this, and some of the following remarks, is derived from Dr HUTTON's ingenious Theory of Rain, an able and beautiful illustration of which we have in Professor LESLIE's Essay "On the Relations of Air to Heat and Moisture," p. 122.

the fewness of the clouds,—the consequent brightness of the atmosphere,—and the rareness of storms, in situations far immured among the northern ice.

From this consideration, it might be supposed, that after the precipitation of a certain small depth of snow on the interior ice, the atmosphere could alone replenish its moisture from the same surface, and that whatever changes of temperature might occur, it could only discharge the same again: or, in other words, that the very same moisture would be alternately evaporated and deposited, without a possibility of adding to a limited depth of snow. Now, this would assuredly be the case, if nothing more than the same moisture evaporated from the snowy surface of ice, were again deposited. But, it must be observed, that notwithstanding winds from the north, east, or west, may not furnish any considerable quantity of snow; and that although those warm and humid storms which blow from the south, may afford a large proportion of their humidity to the *exterior* ice; yet, as the temperature of the northern regions would be gradually elevated, by the long continuance of a southerly gale, the advance of the wind must in consequence be farther and farther before it be reduced to the temperature of the ice; and, therefore, some snow would continue to be precipitated to an increasing and unlimited extent.

Hence, as winds blowing from the north must be replaced by air neither colder nor less damp, and as every commixture with warmer streams, must produce an increased capacity for moisture; therefore, no wind can occasion a detraction of vapour from the circumpolar regions: on the contrary, as the snow deposited on the interior ice by southerly storms, (from the nature of the circumstances), must be derived from evaporations out of the sea; it is evident, that there must be an increase of snow in the icy latitudes, and that we cannot possibly determine any limit beyond which it may be affirmed that no snow can be deposited.

3. On approaching a pack, field, or other compact aggregation of ice, the phenomenon of the *ice-blink* is seen whenever the horizon is tolerably free from clouds, and in some cases even under a thick sky. The *ice-blink* consists in a stratum of a lucid whiteness, which appears in that part of the atmosphere next the horizon. It is evidently occasioned thus: those rays of light which strike on the snowy surface of the ice, are reflected into the superincumbent air, where they become visible; but the light which falls on the sea is in a great measure absorbed, and the superincumbent air retains its native ethereal hue. Hence, when the ice-blink occurs under the most favourable circumstances, it affords to the eye a beautiful and perfect map of the ice, 20 or 30 miles beyond the limit of direct vision, but less distinct in pro-

portion as the air is hazy. The ice-blink not only shews the figure of the ice, but enables the experienced observer to judge, whether the ice thus pictured be field or packed ice : if the latter, whether it be compact or open, bay or heavy ice. Field ice affords the most lucid *blink*, accompanied with a tinge of yellow ; that of packs is more purely white ; and of bay ice, greyish. The land, on account of its snowy covering, likewise occasions a blink, which is yellowish, and not much unlike that produced by the ice of fields.

4. The ice operates as a powerful equaliser of temperature. In the 80th degree of north latitude, at the edge of the main body of ice, with a northerly gale of wind, the cold is not sensibly greater than in the 70th degree, under similar circumstances.

5. The reciprocal action of the ice and the sea on each other, is particularly striking, which ever may have the ascendancy. If, on the one hand, the ice be arranged with a certain form of aggregation, and in due solidity, it becomes capable of resisting the turbulence of the ocean, and can with but little comparative diminution or breaking, suppress its most violent surges. Its resistance is so effectual, that ships sheltered by it, rarely find the sea disturbed by swells. On the other hand, the most formidable fields yield to the slightest *grown* swell, and become disrupted into

thousands of pieces; and ice of only a few weeks growth, on being assailed by a turbulent sea, is broken and annihilated with incredible celerity. Ice, which for weeks has been an increasing pest to the whale-fisher, is sometimes removed in the space of a few hours. The destruction is in many cases so rapid, that to an inexperienced observer, the occurrence seems incredible, and rather an illusion of fancy, than a matter of fact. Suppose a ship immoveably fixed in bay ice, and not the smallest opening to be seen: after a lapse of time sufficient only for a moderate repose, imagine a person rising from his bed,—when, behold, the insurmountable obstacle has vanished! Instead of a sheet of ice expanding unbroken to the verge of the horizon on every side, an undulating sea relieves the prospect, wherein floats, the wreck of the ice, reduced apparently to a small fraction of its original bulk! This singular occurrence, I have more than once been a witness to.

That ice should be forming or increasing, when exposed to the swells of the ocean, while the annihilation of bay ice is so sudden and complete, might seem an anomaly or impossibility, were the circumstances passed over in silence. It must be observed, that the operation of a swell is merely to rend the bay ice in pieces, while its destruction is principally effected, by the attrition of those pieces against each other, and the wash-

ing of the *wind-lipper* *. Herein the essential difference consists: *pancake* ice is formed in masses so small and so strong, that the swell will not divide them; and the effect of the *wind-lipper* is repressed by the formation of *sludge* on its seaward margin. Hence, whenever ice does occur in agitated waters, its exterior is always *sludge*, and its interior pancake ice, the pieces of which gradually increase in size with the distance from the edge.

When a swell occurs in crowded, yet detached ice, accompanied with thick weather and storm, it presents one of the most dangerous and terrific navigations that can be conceived. Each lump of ice, by its laborious motion, and its violent concussions of the water, becomes buried in foam, which, with its rapid drift, and the attendant horrid noise, inspires the passing mariner with the most alarming impressions; whilst the scene before him, is, if possible, rendered more awful, by his consciousness of the many disasters which have been occasioned by similar dangers.

* The first effects of a breeze of wind on smooth water is by seamen, called *wind-lipper*. From it, all high seas are derived, and it is always apparent on their surfaces. Oil cast upon the sea, suppresses the wind-lipper, and a similar effect is produced by the formation of ice *sludge* in the sea, from sudden extreme cold.

On the approximations towards the Poles, and on the possibility of reaching the North Pole.

Although I am sensible, that already I have trespassed too much upon the Society, in the unexpected extent of this paper, I nevertheless cannot think of dismissing the subject, without completing my original plan, by noticing the comparative approximations towards the Poles, which have been effected on different meridians; and at the same time offering, with diffidence, a few remarks on the *possibility of travelling to the North Pole*, together with a sketch of the reasoning on which the probability of success depends.

First, It has already been remarked, that the 80th degree of north latitude, is almost annually accessible to the Greenland whale-fishers, and that this latitude, on particular occasions, has been exceeded. On one of the first attempts which appears to have been made to explore the circumpolar regions, in the year 1607, Henry Hudson penetrated the ice on the north-western coast of Spitzbergen to the latitude of 80° 23′ N. In 1773, Captain Phipps, on "a voyage towards the North Pole," advanced on a similar track to 80° 37′ of north latitude. In the year 1806, the ship Resolution of Whitby, commanded by my Father, (whose extraordinary perseverance and nautical ability are well appreciated by those in the Green-

land trade, and proved by his never-failing success), was forced, by astonishing efforts, through a vast body of ice, which commenced in the place of the usual *barrier*, but exceeded its general extent by at least a hundred miles. We* then reached a navigable sea, and advanced without hinderance, to the latitude of 81½° north, a distance of only 170 leagues from the Pole; which is, I imagine, one of the most extraordinary approximations yet realised.

In Hudson's Bay, between the longitudes of 50° and 80° west, ships can seldom advance beyond the 74th degree of north latitude; and only one instance is upon record, wherein the extremity of the bay in 78° N. has been explored.

In Behring's Straits, the adventurous Cook, on the meridian of 161½° W. (very near the American coast), advanced to the latitude of 70° 44′ N., on the 18th of August 1778; and on the 26th, in longitude 176° W., they were stopped by the ice in 69° 45′ N. After his lamentable death, Captain Clerke directed the proceedings in the following year, and reached the latitude of 70° 33′ on the 18th of July, being about four leagues short of their former advance.

The southern hemisphere, towards the Pole, was likewise explored by Captain Cook on a

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* I accompanied my Father on this voyage, in the capacity of chief mate.

former voyage, on various meridians, and with indefatigable perseverance. On his first attempt in 1772, they met with ice in about 51° south, and longitude 21° east. They saw great fields in 55° south on the 17th of January 1773, and on February the 24th, were stopped by field-ice in 62° south latitude, and 95° east longitude.

Again, on the second attempt in December of the same year, they first met with ice in about 62° south latitude, and 172–173° west longitude; and on the 15th, saw field ice in latitude 66°. On the 30th of January 1774, they were stopped by immense ice-fields in latitude 71° 10′ 30″, and 107° west longitude, which was the most considerable approximation towards the South Pole that had ever been effected.

Thus, it appears, that there subsists a remarkable difference between the two hemispheres, with regard to the approach of the ice towards the equator; the ice of the southern, being much less pervious, and extending to much lower latitudes, than that of the northern hemisphere:—

That the 73d or 74th degree of north latitude can be attained at any season of the year; whereas the 71st degree of south latitude, has been but once passed:—And,

That, whilst the antarctic *ne plus ultra* appears to be the 72d degree of latitude, that of the arctic extends full 600 miles further; the nearest ap-

proach to the South Pole being a distance of 1130 miles, but to the North, only 510 miles.

Lastly, With regard to the probability of exploring the regions more immediately in the vicinity of the Pole than has yet been accomplished, or even of reaching the Pole itself,—I anticipate, that without reference to the reasoning on which the opinion is grounded, it might be deemed the frenzied speculation of a disordered fancy. I flatter myself, however, that I shall be able to satisfy the Society, that the performance of a journey, over a surface of ice, from the north of Spitzbergen to the Pole, is a project which might be undertaken, with at least a probability of success.

It must be allowed, that many known difficulties would require to be surmounted,—many dangers to be encountered,—and that some circumstances might possibly occur, which would at once annul the success of the undertaking. Of these classes of objections, the following strike me as being the most formidable, which, after briefly stating, I shall individually consider, in their order:

1. The difficulty of performing a journey of 1200 miles, 600 going and 600 returning, over a surface of ice,—of procuring a sufficient conveyance,—and of carrying a necessary supply of provisions and apparatus, as well as attendants.

The difficulty may be encreased by

(*a.*) Soft snow;

(*b.*) Want of the continuity of the ice;

(*c.*) Rough ice; and

(*d*) Mountainous ice.

2. The difficulty of ascertaining the route, and especially of the return, arising from the perpendicularity of the magnetical needle.

3. Dangers to be apprehended,

(*a.*) From excessive cold;

(*b.*) From wild beasts.

4. Impediments which would frustrate the scheme:

(*a.*) Mountainous land;

(*b.*) Expanse of sea;

(*c.*) Constant cloudy atmosphere.

1. It is evident that a journey of 1200 miles, under the existing difficulties, would be too arduous a task to be undertaken and performed by human exertions alone, but would require the assistance of some fleet quadrupeds, accustomed to the harness.

Rein-deer, or dogs, appear to be the most appropriate. If the former could sustain a sea voyage, they might be refreshed on the northern part of Spitzbergen, which affords their natural

food. They could be yoked to sledges framed of the lightest materials, adapted for the accommodation of the adventurers, and the conveyance of the requisites. The provisions for the adventurers, for compactness, might consist of portable soups, potted meats, &c., and compressed lichen for the rein-deer. The instruments and apparatus, might be in a great measure confined to indispensables, and those of the most portable kinds; such as tents, defensive weapons, sextants, chronometers, magnetic needles, thermometers, &c.

As the rein-deer is, however, a delicate animal, difficult to guide, and might be troublesome if thin or broken ice were required to be passed,—dogs would seem in some respects to be preferable. In either case, the animals must be procured from the countries wherein they are trained, and drivers would probably be required with them. The journey might be accelerated, by expanding a sail to every favourable breeze, at the same time, the animals would be relieved from the oppression of their draught. It would appear from the reputed speed of the rein-deer, that, under favourable circumstances, the journey might be accomplished even in a fortnight, allowing time for rest and accidental delays. It would require a month or six weeks with dogs, at a moderate speed; and, in the event of the failure of these animals on the journey, it does not seem impossible that the re-

turn should be effected on foot, with sledges for the provisions and apparatus.

(*a.*) Soft snow would diminish the speed, and augment the fatigue of the animal; to avoid which, therefore, it would be necessary to set out by the close of the month of April or the beginning of May; or at least, some time before the severity of the frost should be too greatly relaxed.

(*b.*) Want of continuity of the ice, would certainly occasion a troublesome interruption; it might nevertheless be overcome, by having the sledges adapted to answer the purpose of boats*; and it is to be expected, that although openings amidst the ice should occur, yet a winding course might in general be pursued, so as to prevent any very great stoppage.

(*c.*) Many of the most prodigious fields, are entirely free from abrupt hummocks, from one extremity to the other, and field ice, as it appears in general, would be easily passable.

(*d.*) The degree of interruption from mountainous ice, would depend on the quality of its surface. If, as is most probable, it were smooth, and free from abrupt slopes, it would not prevent the success of the expedition.

* The sledges might consist of slender frames of wood, with the ribs of some quadruped, and coverings of water-proof skins, or other materials equally light.

2. The direct route would be pointed out, for some part of the way at least, by the magnetic needle; and when its pole should be directed towards the zenith, should that position ever obtain, the sun would be the only guide. Or, the position of the true north being once ascertained, three sledges on a line, at a convenient distance apart, might enable the leading one to keep a direct course. A chronometer would be an indispensable requisite, as the opportunity for lunar observations could not be expected to occur sufficiently often. Were the Pole gained, the bearing of the sun at the time of noon, by a chronometer adjusted to the meridian of North-west Spitzbergen, would afford a line of direction for the return; and, the position in regard to longitude (were the sun visible) could be corrected, at least twice a-day, as the latitude decreased. The degrees of longitude being so contracted, any required position would be pointed out by the watch, with the greatest precision.

3. (*a.*) Among the dangers to be apprehended, the coldness of the air stands prominent. As, however, the cold is not sensibly different, between the latitudes of 70° and 80° with a strong north wind, it may be presumed that at the Pole itself, it would be very little more oppressive than at the borders of the main ice, in the 81st degree of north latitude, under a hard northerly gale: And since this cold is supportable, that of the Pole may be deemed so likewise. The injurious effects

of the severity of the weather, might be avoided by a judicious choice of woollen clothing; the external air being met by an outward garment of varnished silk, and the face defended by a mask, with eyes of glass. The exterior garment, would, at the same time, be water-proof, and thus capable of shielding the body from accidental moisture.

(*b.*) The white bear is the only ferocious animal known to inhabit those regions, and he rarely makes an attack upon man. At any rate, he might be repulsed by any offensive weapon. And, as the prey of the bears is scarce in the most northern latitudes, they would not probably occur in any abundance.

4. Hitherto no insurmountable objection has been presented: a few serious obstacles, should they occur, remain to be considered.

(*a.*) Mountainous land, like mountainous ice, would check the progress of the expedition, in proportion to the ruggedness of its surface, and the steepness of its cliffs. Its occurrence would, nevertheless, form an interesting discovery.

(*b.*) From the pretended excursions of the Dutch, many have believed that the sea at the Pole is free from ice; were this really the case, the circumstance would certainly be an extraordinary one; but I consider it too improbable to render it necessary to hazard any opinion concerning it.

(*c.*) From the facts stated in pages 319, 320 of this paper, I think we derive a sanction for calculating on clear weather at all times but with southerly storms; and, as these occur but rarely, the progress of the journey would not probably be suspended by an obscure sky, except for short periods and at distant intervals.

Notwithstanding I have now distinctly considered every obvious objection and difficulty to be surmounted, I am nevertheless sensible, that in the realising of any project for discovery, whether at sea or on land, there will occur many adventitious circumstances which may tend to mar the progress of the best regulated expedition. Therefore, it may not be improper to confirm and strengthen the whole, by directing the attention, to what has been done, in journeying under difficulties which may bear a comparison with the undertaking here alluded to, and occasionally under circumstances the most unfavourable for success.

1*st*, When treating of icebergs, I alluded to the journey of Alexei Markoff, in which it appears, that he performed near eight hundred miles across a surface of packed ice, in the spring of 1715, in a sledge drawn by dogs; and consequently, that he might be supposed to have encountered the principal difficulties that could be expected in the proposed scheme, whilst we have the advantage of improving by his experience.

2d, Speaking of the south-western tendency of the ice, I have also noticed, the loss of several of the Dutch Greenland fleet in 1777, from which we learn, that part of the unfortunate suffering crews, under every privation of provision and clothing, and exposed to the severity of an arctic winter, accomplished a journey on foot, along the coasts of Old Greenland, from the east side near Staten-Hook to the Danish settlements on the west, a distance of near a hundred leagues.

3d, On contrasting the projected polar journey with the catalogue of marvellous occurrences, and wonderful preservations which are exhibited in the records of maritime disasters *, the difficulties of the undertaking, in a great measure vanish, and its dangers are eclipsed, by the wonderful results which necessity has in various instances accomplished.

Note.—It may not be improper here to observe, that I am aware that the preceding remarks are capable of considerable extension, and of various

* See "Shipwrecks and Disasters at Sea."

illustrations. The consideration, that I was writing for a learned society, prevented the necessity of entering into the *minutiæ* of explanation, which would have been requisite in a communication intended for the world at large. For instance, I did not think it needful that I should inform the Society how the course of a journey to the Pole, in the event of the failure of the magnetic needle, might be regulated by the varying position of the sun; or, in what way the longitudinal situations would be determined by the chronometer. In a work which I am now preparing for the press, the preceding paper, amplified and illustrated, is intended to be introduced. My plan embraces the following general heads:

I. An account of the progress of discovery in the North, with a synopsis of the numerous voyages undertaken in search of a Northern Passage to India.

II. An account of West Greenland:—its extent, appearance, natural history, aborigines, colonies, manners and customs of the inhabitants, &c.

III. East Greenland or Spitzbergen:—its appearance, natural history, harbours, icebergs, mountains, colonisation, products, &c.

IV. The natural history of the Greenland Seas; containing,

1st, An account of the Greenland Sea:—its situation and extent, temperature both at the surface and at considerable depths, currents, tides, depth, &c.

2d, The Polar Ice:—its varieties and properties, mode of generation, &c.:—its extent, situation, and variation; with remarks on the practicability of performing a journey over the ice to the North Pole.

3d, The Atmosphere:—its changes of pressure, &c.:—its temperature, probable temperature of the North Pole, &c.:—Winds, their duration and frequency of storms in the spring of the year, &c.:—Meteors, clouds, snow, and its numerous crystallisations, hail, frost-rime, aurora borealis, &c.

4th, The Zoology:—the whale and its various genera:—the walrus, seal, bear, &c.:—birds:—non-descript mollusca, and other marine animals, &c.

V. The History of the Northern Whale-Fishery; shewing its progress, with an account of those principles on which a successful fishery depends, &c.

VI. The History of the Minor Fisheries:—for seals, walruses, &c.:—with the method of kill-

ing these and other animals, inhabitants of the Greenland Seas.

VII. A Journal of a Greenland Whale-Fishing Voyage.

VIII. Appendix; containing, a series of Meteorological Tables:—Tables of the Variation of the Compass, Latitudes, and Longitudes, &c. from original observations.

XXII. *On the Mineralogy of the Redhead in Angusshire.*

By the Rev. John Fleming, D. D. F. R. S. E.

(*Read 4th February* 1815.)

In the beginning of the month of August last, I spent a few days at Aberbrothick in Angusshire, for the purpose of examining the marine *vermes* of that part of the eastern coast of Scotland. In my walks along the shore, I observed some appearances in the stratification of the rocks, which attracted my notice, and from the notes taken of these at the time, I have drawn up the following observations, which I submit to the consideration of the Society.

Between the Bay of Aberbrothick on the south-west, and Lunan Bay on the north-east, the coast is extremely bold and rocky; and for the space of six miles, presents to the German Ocean, pre-

cipitous, broken, and indented cliffs. The highest point, where there is a precipice rising from the sea to the height of 254 feet, is at the flagstaff to the eastward of the House of Ethie, the seat of the Right Honourable the Earl of Northesk. All the rocks of this promontory, are of a reddish colour, and from that circumstance, it has been denominated by mariners the *Redhead;* the inhabitants of the district, however, restrict the name to the high rocks which appear to the south of the ruins of St Murdoch's Chapel.

From this promontory, inland, the surface falls with a gentle slope, and at last forms the plain through which two small rivers, the Brothick and the Lunan flow. The *Brothick Burn*, towards its mouth, runs in a southerly direction, and falls into the sea at the Town of Aberbrothick, commonly called Arbroath. It winds its course through a narrow valley, which is from one to two hundred yards in breadth. The sides of the valley, which consist of strata of sand, of coarse sand and gravel, though much waved, are in general parallel to each other, the salient angles of the one corresponding with the receding angles of the other; the bottom consists of fine earthy sand and gravel. In the centre of this valley, there is a conical hill, on the summit of which the ancient Church of St Vigeans is situated. This hill is composed of soft sandstone, which is covered to the top with a thick coating of gravelly mould.

The Brothick Burn appears to have formed its own channel in the soft alluvial strata through which it flows. The bottom of the valley is of considerable extent, when compared with the narrow bed which contains the river in the drought of summer; but when the stream is swollen with autumnal floods, or choked with the ice and snow of winter, the valley itself, unless prevented by artificial barriers, would then become the bed of the river, as its smooth surface indicates it at one time to have been. When the present bed of the river shall have acquired sufficient depth to contain all the water which at any season flows in it, then a new flat will be formed on each side, and the banks will present that terraced appearance which may be observed on the sides of many streams which have scooped out their channels in loose and soft materials. The opposite banks of rivers, may always be expected to be parallel where the materials of which they are formed are similar in composition: having obtained such a relation at first, they have been exposed to the influence of the same destructive agents in every subsequent period.

The beds of gravel and sand, which form the banks of the Brothick, are connected with similar depositions, which occur in the neighbourhood. Near the Town of Aberbrothick, there are numerous hills of gravel, which appear to have a north-westerly direction. The gravel is frequently coarse, and consists of rounded masses of granite,

gneiss, mica-slate, quartz, porphyry, greenstone, basalt, and red-sandstone, with interposed layers of fine sand. It sometimes alternates with beds of sand composed of small particles of quartz and felspar, and numerous scales of silvery mica. The gravel is in many places so firmly cemented, that the hand is unable to separate the individual masses, and the particles of sand often cohere, and form a sandstone which can be divided into strata by means of a knife. Sometimes beds of clay occur, which have a laminated structure, and indicate a deposition from a fluid but little agitated.

The eastern base of these hills, is truncated, and the intervening space between their extremities and the shore is level, and consists of a soil composed of gravel, mixed with the remains of sea-shells. The lower or southern portion of the Town of Aberbrothick, rests upon strata of sea-borne gravel, mixed with the fragments of several species of littoral shells. This portion is elevated but a few feet above the ordinary rise of spring-tides, and is liable to inundations of the sea during great storms. It appears, that at a former period, a considerable portion of land had been gained from the sea, especially along the coast to the south of the town; but the currents having changed, Neptune is again resuming his dominion over those tracts which he formerly relinquished,

and is at present making very rapid encroachments upon the land.

The *Lunan Burn*, which empties itself into the German Ocean at the head of Lunan Bay, runs in a valley in every respect similar to the Brothick. The alluvial hills which occur towards its mouth, have been greatly altered in form by the operations of agriculture, but they evidently present the same abrupt terminations towards the sea, which we have noticed above. They are defended from any farther encroachments of that element, by a number of low ridges of drifted sea-sand, closely held together by the roots of the *Elymus arenarius, Arundo arenaria, Carex arenaria*, and *Triticum junceum*.

The structure of these hills of gravel, deserves very particular consideration. Far from being a mere heap of rubbish, the beds of sand are often continuous and of considerable extent, and the rolled masses of gravel are deposited in beds with considerable regularity. These beds do not always possess a horizontal position, but present in their stratification a few of those appearances which are usually considered as peculiar to the more ancient strata. Thus, on the banks of the Lunan, about a mile east from Kennell, I observed beds of sand and fine gravel, inclining to the horizon, at an angle of 20° ; and on the extremities of these beds, were deposited strata of gravel, dipping in an opposite direction at an angle of 15°.

Another appearance of the same kind presented itself to the north-east of the church of St Vigeans, in an opening made in a field for the purpose of obtaining gravel for the roads. Immediately under the soil, there is a horizontal bed of gravel, containing thin layers of sand, resting upon the extremities of strata of coarse sand, dipping E. S. E. at an angle of 24°.

It is assumed as a first principle in the Huttonian Theory, that all the mineral strata at their formation, were deposited on a horizontal plane. Loose materials, it is said, such as sand and gravel subsiding at the bottom of the sea, and having their interstices filled with water, possess a kind of fluidity, and therefore would arrange themselves in horizontal layers. The figure of the lower beds deposited on an uneven surface, would be affected by two causes, the nature of that surface on the one hand, and the tendency to horizontality on the other; but the latter cause would finally prevail. "Whenever, therefore, we meet with rocks disposed in layers quite parallel to one another, we may rest assured, that the inequalities of the bottom have had no effect, and that no cause has interrupted the statical tendency *." But the phenomena described above furnish evidence by which this assumption may be successfully resisted. Here are parallel strata of coarse sand,

* Illustrations of the Huttonian Theory, p. 43.

having an inclination of 24°, which have been deposited from a state of suspension in water. Had the water been in a state of rest, these strata must have assumed a horizontal position, but if we suppose the water to have been in a state of motion, we have then the influence of a new agent to consider, which may lead us to the conclusion, that the motion of a fluid depositing suspended earthy matter, modifies the statical tendency of that matter to horizontality. If the cause now mentioned be considered capable of giving an inclined position of 24° to strata formed from coarse materials mechanically suspended in water, at what angle are we to fix the maximum of its effect, at 24° or at 90°? and are we to confine its operation to the construction of the recent beds of gravel and sand, or suppose its influence to have been exerted at the formation of the more ancient strata of the globe?

We may add, that these beds of gravel occur at the eastern extremity of the great valley of Strathmore, and in all probability were formed at the time when this valley was an inland lake. The masses of gravel are neither smooth on the surface, nor regularly rounded, as we always observe in sea-gravel. It is also worthy of notice, that similar beds of gravel and sand had been formed in the same place, but at a period more remote, which now appear in the form of solid rock.

At Wormy Hills, near Aberbrothick, there is a *mineral well.* The water is a strong chalybeate, and

deposites around its margin and that of the stream which runs from it, a copious ferruginous precipitate. I was surprised to find in the ochry mud, within a few yards of the spring, two species of fresh-water shell-fish, the *Cyclus cornea*, and the *Lymnæa putris*.

Having thus offered a few remarks on the form and structure of the Alluvial strata, I shall now state the observations which I had an opportunity of making on the Flœtz rocks of the district. The general line of bearing which these rocks observe, is from east to west, varying in some places a few degrees to the north of east, and the south of west. The dip is towards the south, at various angles, but seldom below ten or above twenty-five degrees, and the strata preserve nearly the same degree of thickness in the different parts of their course. The rock which we shall first describe, is,

1.—Red Sandstone. The rocks of sandstone appear on the coast to the south of the harbour of Aberbrothick, and extend in a north-easterly direction to the flag-staff at Ethie, including a space of nearly five miles. On the great scale, they may be considered as forming one great bed, nearly two miles in thickness, divided into regular strata,

some of these exceeding four feet, others only a few lines in thickness. These strata are divided by perpendicular rents, (or *backs* as they are termed by the quarrymen,) which run at right angles to the line of bearing, are parallel to one another, and often cause the rock to exhibit somewhat of a columnar appearance. This structure has enabled the sea to make great encroachments, and has contributed to give to the scenery its characteristic feature of boldness. When the sea undermines the base of these angular masses, they fall with a tremendous crash, and leave the newly exposed surface of the rock a mural precipice. But it often happens, that the upper portions of the columns are too firmly wedged by the surrounding rock to allow them to be displaced, so that the inferior portions only give way, and in this case, a small cave is formed, which is very speedily enlarged by the surf of an exposed and stormy coast.

In the promontory of the Redhead, there are a number of caves situated in the rocks of sandstone, and some of them are of considerable magnitude. These afford the seal and the otter a safe retreat during the breeding season, enable the superstitious natives to contemplate the ghastly spectres of Pandæmonium, and have been supposed to exhibit to the geologist a proof of the sea having formerly exerted its influence at a higher level than the ordinary rise of its present

tides. The floors of many of these caves being elevated above high-water mark, have led some to infer a rising of the land or a depression of the level of the sea, subsequent to the period of their formation,—suppositions equally gratuitous and unnecessary. If a small cavity is once formed in the soft sandstone, (and caves are always situated in the softer parts of the strata), within the reach of the tide, it will speedily be hollowed out into a cave by the action of the surge, and this cavity will increase in length and height more rapidly than in breadth and depth. The innermost part offering the greatest resistance, will be assailed most violently by the force of the sea; and the floor will acquire an inclination, rising as the cave increases in length, in consequence of the direction given to the progressive motion of the littoral waves by the sloping position of the shore. During a storm, the external opening will act like a funnel, and conduct each billow, with its ascending motion, to spend its destructive force in the farthest part of the cave, and there scoop out a recess greatly beyond the reach of an ordinary tide. If the outworks of this recess are removed by the action of the sea, a cave will then open to-day, with its floor higher than the present level of the ocean. There are many caves both on the east and west coasts of Scotland, which have formerly been excavated by the action of sea, but whose pavements at present are never washed by the tide. These, in all pro-

bability, owe their origin to the cause which I have here pointed out.

The strata of sandstone in this district, observe the general direction and inclination of the beds to which they belong, unless in a few instances, where the structure of individual strata presents marks of irregularity of deposition. Thus, to the south of the harbour of Aberbrothick, the thin laminæ which form a stratum, are often unconformable among themselves, while the roof and pavement of the bed are parallel to each other. Appearances of this kind are very common in every sandstone-rock, and in every alluvial hill of water-borne sand. In the last of these, such appearances have been occasioned by irregularities in the motion of the fluid which gave the particles their arrangement. May we not infer the agency of a similar cause in the production of similar appearances in strata of sandstone?

In one instance, I observed a little irregularity to prevail, not only in the dip, but also in the direction of the strata, but which irregularity, in the great scale, did not affect the general disposition. To the south of the last-mentioned place, strata of soft slaty sandstone stretch E. by N. and W. by S., and dip at angle of 20° S. by E. When proceeding in this direction, they are interrupted by other strata of sandstone, coarser and more compact, which stretch from S. S. W. to N. N. E., and dip at an angle of 50° to the E. S. E. These cross strata, which extend in their line of bear-

ing upwards of a hundred yards, are included on all sides by the regular strata, observing the general dip and direction, except on the western side, where the direction changes from W. by S. to W. S. W. The regular strata at the north side of this interruption, are much intersected by veins of limespar *. Can we account for this appearance, otherwise than by supposing, that a partial change in the direction of the depositing fluid occasioned this limited irregularity; a disturbing force acting laterally or from below, must have changed at the same time the position of the accompanying beds. Such irregularities in the stratification, ought to be studied with care, as they yield instruction to the miner, and afford the geologist a touchstone by which to try the truth of his theory.

To the south of the harbour of Aberbrothick, the strata of sandstone are from one to three feet in thickness, split into thin laminæ, and the particles cohere very feebly. When pieces of this rock are first raised from the bed, they can be cut into slices with a knife, or crumbled to powder by the fingers; but after they have been ex-

* I have here used the term *calcareous-spar*, because sanctioned by use and high authority. Perhaps the name *limespar*, a compound of two *English* words, would be more appropriate, and preserve a greater uniformity in mineralogical nomenclature.

posed for some time to the action of the atmosphere, they acquire a considerable degree of hardness. When a fresh piece of the rock is put into a glass with water and agitated, the cohesion between the particles is destroyed, and when the fluid is suffered to rest, the ingredients of the stone divide themselves into three portions. At the bottom is found a fine gritty sand, in the middle small scales of mica, and at the top a portion of argillaceous matter, which continues longest suspended in the water. The hardness which the stone acquires by exposure to the atmosphere, is probably owing to the desiccation of this last substance. In these soft strata, water-borne balls of quartz, granite, gneiss, mica-slate, porphyry, and trap, lie scattered without order, and in some places they are accumulated in such quantity, as to constitute the rock to which Colonel Imrie has attached the very appropriate name of *gravelstone*. Sometimes these strata include beds of coarse sandstone, composed of angular grains of quartz and felspar with a little mica, which are less liable to detrition from the action of the sea.

Immediately to the north of the harbour, similar strata prevail, but the quantity of gravel imbedded in the strata is much greater, and the beds of gravelstone more numerous. In some instances, these rounded balls, which are from a line to a foot in diameter, are cemented to-

gether by lime-spar, which occurs in great abundance.

Proceeding about a mile to the north-east of the harbour, the high cliffs of the Redhead commence. Here the sandstone is of a more compact texture, and appears better able to resist the attacks of the waves, so that while the strata to the south have been worn down, and the bay of Aberbrothick now occupies their place, those to the north, still form high and lofty precipices, and yield but slowly to the action of the sea. In examining bays and arms of the sea, we invariably find, as in this instance, that they are situated in softer strata than those which occur on the neighbouring projecting shores; and the rocks which form the base of valleys, are less compact in their texture than those which constitute the surrounding hills,—facts which prove, that many of the inequalities of the earth's surface owe their existence to the long-continued action of air and water.

The sandstone on this part of the coast, is of a pale reddish-brown colour, minutely freckled with grey. It frequently presents narrow stripes and circular spots of ash-grey, or primrose-yellow, and sometimes whole beds of a white colour, may be observed. It appears to consist of minute grains of sand, with a few scales of mica, connected by a basis of iron-shot clay-marl. The particles of sand in some cases are so numerous, that the stone has a very coarse texture, and in many instances appears in the form of gravelstone. When this

sandstone is first raised in the quarry, it is very soft, and is easily cut with the working-tools; after exposure for a short time to the atmosphere, it becomes a little harder, but is by no means a very durable material for buildings. When exposed in a wall or house, the surface which has been dressed with the chisel, remains entire until the portion immediately beneath becomes disintegrated, when the external film falls off. After the artificial surface has been removed, the particles crumble down in succession as they separate from the mass. Is it the pressure of the chisel in the dressing of the stone, which, bringing the particles at the surface into closer contact, enables them to resist longer the influence of the atmosphere? Would it not be advisable to beat the surface of the stones with a hammer, before using them in building, in order to communicate the requisite durability? The Old Abbey of Aberbrothick is constructed of this kind of rock, and the mouldering surfaces of the stones make the venerable ruins appear still more ruinous*.

In several places, the rock is composed of blunt angular pieces of sandstone, imbedded in a basis of a similar composition. This structure does not appear to the eye, unless the stone has been ex-

* There was a considerable quantity of fibrous gypsum found some time ago among the rubbish of this abbey. It may have been found in the sandstone-rocks of the neighbourhood, but of this no proof exists at present.

posed for some time to the influence of the atmosphere, the fresh fracture presenting a homogeneous surface. These pieces, which appear at first sight to be fragments, are merely contemporaneous portions of the rock; they present no rounded water-worn surface, and at one extremity, at least, pass by an insensible transition into the rock in which they are enveloped. The term *sandstone-conglomerate*, ought to be restricted to denominate this kind of rock, as it must either mean sandstone in the form of fragments or balls, or sandstone in heaps. When the term includes the gravelstone of Colonel IMRIE, it evidently has obtained too great a latitude of signification *.

In all the preceding strata of sandstone, there occur beds of *slate-clay*, seldom above a foot in thickness, and of a similar colour to the surrounding rock. The slate-clay is often in the form of angular pieces included in the sandstone, in which it also occurs in indistinct layers. The longitudinal fracture is usually glimmering, the cross fracture dull. It passes, on the one hand, into

* Limestone-conglomerate, in the restricted sense of the term, is a rock of frequent occurrence. It may be observed in Arthur's Seat, at Innerkip in Renfrewshire, and near the Rumbling Bridge in the county of Perth. In all these situations, it appears to be an inmate of the old red sandstone formation. I consider Arthur's Seat as a portion of this formation. Several facts in proof of this, may be found in WILLIAMS's *Mineral Kingdom*.

fine-grained sandstone; and on the other, into a mineral which may be termed *compact clay.*

This mineral is of an ash-grey colour, sometimes also reddish-brown; fracture compact, even, passing into fine earthy; fragments indeterminately angular, rather blunt-edged; translucent on the edges; dull; streak light-coloured; soft, passing into semi-hard; easily frangible; adheres a little to the tongue; rather heavy. When heated, and afterwards exposed to the air, it crumbles down into a very coarse powder. This substance, which is probably a combination of silica and alumina, with a little iron, occurs in globular-shaped masses, from half an inch, to nearly a foot in diameter. These are compressed, with an irregular margin, and in general an uneven surface. They lie on their sides in the beds of sandstone, especially where it passes into slate-clay, and often also where it is soft and micaceous. Although they occur insulated, yet they seem to preserve a regular direction in the beds in which they are included. The central parts of these masses, are traversed by horizontal and vertical rents, which do not make their appearance at the surface. These rents are widest towards the centre, and are in general filled with limespar; sometimes completely, at other times, only in part. These balls appear to bear the same relation to sandstone, which the septarium is known to bear to slate-clay in which it is usually imbedded.

In these globular concretions, which are much harder than the surrounding rock, different species of the shells termed *borers*, form their retreats. I observed the following:—*Mytilus rugosus*, *Mya suborbicularis*, *Venus perforans*, and *Venus pullastra* of the *Testacea Britannica* of MONTAGU.

2.—SANDSTONE-CONGLOMERATE. The rock to which this name has been applied, consists of portions of the older rocks of granite, gneiss, mica-slate, quartz, porphyry, and hornblende. These are in the form of rounded balls, or blunt angular fragments, seldom above six inches in diameter. The interstices between the balls, are filled up with smaller fragments of similar materials, and the rock possesses a considerable degree of cohesion. In this rock, there are numerous narrow lines of sandstone, sometimes also thin beds parallel with the surface of the stratum which encloses them. Similar appearances are observable in the hills of gravel.

This conglomerate, or gravelstone, occurs in two different situations. In the first, it alternates in beds with the sandstone, as we have already mentioned; and in the second, it occupies an unconformable position in regard to the sandstone. At the western extremity of the high cliffs, which terminate about a mile to the eastward of Aberbrothick, the strata of sandstone rise with an inclination of 18°. The extremities of these strata, are covered with a

mass of gravelstone, upwards of thirty feet in thickness, and extending in length a considerable way along the coast. The gravelstone is divided into horizontal strata, and contains numerous partial beds of sandstone. In one place, I observed in the gravelstone an angular mass of sandstone, precisely similar to the beds of sandstone below the gravelstone, which mass was surrounded on all sides by calcareous-spar, or limespar, and the spar also filled up a small linear vein which penetrated to its centre. This fact incontestibly proves, that the sandstone below was formed some time before the gravelstone, and had even acquired a sufficient degree of induration to admit of fragments being detached, while the sharp edges of the fragments shew, that it had not travelled far from its original situation. The two rocks of gravelstone and sandstone, are separated by a well defined line, which also proves the posterior formation of the incumbent mass.

In one place, there is a small perpendicular rent in the inferior sandstone, wide towards the top, but becoming narrow, and at last terminating about four feet from the separating line, which divides the two rocks. Into the mouth of this rent, the smaller balls of the gravelstone have descended, and filled up the superior portion of the cavity, and the finer particles of sand have filled up the inferior narrow portion. And it is remarkable, that the slaty fracture of the sandstone

at the bottom of the vein, is parallel with the sides of the fissure. The sandstone in the vein, is much impregnated with calcareous matter, and even contains interspersed crystals of calcareous-spar. This is a very fine illustration of the theory of veins.

This conglomerate, in another place, appears in an unconformable position with regard to the sandstone. A little to the south of the small fishing village of Auchmithie, the common sandstone is suddenly intercepted by a vertical vein of Heavy-spar, nearly two feet in breadth; and on the other side of this vein, the gravelstone appears containing many small beds of sandstone. This conglomerate, which comes thus suddenly in contact with the sandstone, is seen to be in unconformable position, as at a little distance it rests its horizontal strata upon the extremities of the more inclined strata of sandstone. Similar appearances in the stratification, are observable in the beds of porphyry and sandstone to the west of Dundee *.

These two rocks which have now been described, must be referred to the class of mechanical deposits, as the eye is unable to discriminate between the sand and gravel, and the rocks of sandstone and gravelstone, the form and structure of the beds being the same. Viewing them, therefore, in this light, whence have the materials, and

* See p. 139. of this volume.

whence the cementing matter been derived? The origin of the former, is easily ascertained, as they consist of water-worn fragments of the ancient strata. The cementing matter of the conglomerate, is in some cases calcareous-spar; but in general the larger balls rest in a basis, consisting of minute grains of quartz and felspar, without any cement visible to the naked eye. The cohesion in this case, may be owing to disseminated, clayey, or ferruginous matter, with which the water may have been charged during the period of deposition, assisted by the great pressure to which the materials must have been subjected, both from the superincumbent mass of water, and the weight of the materials of the superior strata. That the waters, during the deposition of this portion of the flœtz class, were charged with ferruginous matter, is evident from the colour which characterises the formation, in whatever quarter of the globe it has been discovered, and which is not generally observed in the sandstone of any subsequent period. The quantity of clayey marl, which forms the basis of many of the strata of sandstone, may be regarded as in its original state, and may be viewed as bearing the same relation to the grains of sand and gravel, as compact limestone does to the animal relics which it encloses. The sand and organic remains, must be considered as mechanical deposits, the former unaltered, the latter changed by the mysterious process of lapidification.

These appearances of the sandstone-conglomerate and gravelstone, seem to indicate the operation of a disturbing force, acting on the water, from which these beds were deposited, but of its nature or direction, we will probably forever remain ignorant.

I have before mentioned, that the rocks of sandstone extend from Aberbrothick to the flag-staff at Ethie; but to the north-east of the flag-staff, and near to the ruins of St Murdoch's Chapel, these rocks terminate, and are succeeded by beds of trap, which form the cliffs on the shore to Lunan Bay, and towards Montrose. These rocks of trap, which are termed by the inhabitants *scurdie*, possess none of those perpendicular fissures which characterise the cliffs of sandstone, and hence towards the sea, they present a surface more irregular and broken. The beds are of considerable thickness, sometimes upwards of ten feet, and at other places only a few inches. Although somewhat irregular, yet the stratification can be distinctly traced, and it corresponds exactly with the sandstone, both in direction and dip. This is very distinctly displayed on the shore, where the line of junction is visible; and in the general direction of the rocks inland, numerous quarries being opened in the rocks of scurdie to obtain materials for repairing

the roads, and these mark the boundaries of the two rocks.

Where the sandstone-rocks terminate, they are seen to rest upon a bed of *porphyry-conglomerate.* When this rock is fresh and untarnished by the weather, it presents a uniform surface; but where it is beginning to decompose, its angular fragments become visible. These are somewhat blunt in the edges, and generally pass imperceptibly into the basis in which they are imbedded, although at times, these pieces have a smooth surface on one or two sides, as if a little worn by attrition, while at the other extremity, they blend with the general mass. The whole bed is composed of the same kind of rock,—a claystone, with numerous crystals of earthy felspar. This bed is upwards of twenty feet in thickness, and rests upon a bed of slaty-sandstone-conglomerate, or a sandstone in apparent fragments, imbedded in a basis of a similar composition, and possessed of a slaty fracture. The pavement of this sandstone, would have been invisible, had not a *slip* taken place, by which the strata are better exposed, and the sandstone is seen to rest upon a bed of porphyry-conglomerate, precisely similar to that which forms its roof. To this last bed of porphyry, succeed strata of amygdaloid, in many places passing into trap-tuff.

The *amygdaloid* varies much in its composition. The basis in some cases, appears to be wacke, in

others claystone or compact felspar. It often assumes a homogeneous aspect, and passes into massive compact felspar, felspar-porphyry, or porphyritic-slaty-felspar. In other cases, the felspar passes into clinkstone, basalt, and greenstone, containing small specks of diallage. In this assemblage, I observed several partial beds of fine-grained sandstone, of a grey, greenish, or brown colour. In some places, these occur in connected masses, upwards of a hundred yards in length and breadth, while they do not exceed a foot in thickness. It is impossible to consider these in any other light, than as beds of sandstone, originally deposited in the places they now occupy, as their direction is always conformable with the surrounding rock. In one place, I observed a partial bed of sandstone, in the form of flat anastomosing branches; the intermediate spaces being filled with claystone-porphyry. In another place, the sandstone was imbedded in felspar-porphyry, into which it passed by an insensible boundary, and included portions of the felspar, whose surfaces were intimately incorporated with the sandstone. All these rocks, which I have mentioned as included in the amygdaloid, are seen to traverse it in the form of contemporaneous veins. Even the sandstone in one place formed a vein, intimately united with the amygdaloid at the sides, and having the direction of the slaty fracture parallel with the surface of the bed; in this

respect differing from a true vein. It was about six inches in breadth, and could be traced for several yards.

The vesicles of the amygdaloid, are frequently very small, but in general they are from half an inch to three inches in diameter, of a globular form, and in some instances compressed and club-shaped. These lengthened vesicles observe no particular direction in the bed, being sometimes parallel, and at other times perpendicular to its surface. When the rock is soft, these vesicles occur in greatest abundance; where it is very hard and dense, they are seldom observed. These vesicles are filled with various substances, as limespar, quartz, flint, calcedony, jasper, and green-earth. This last-mentioned substance often fills up entirely the cavities, at other times only partially. Quartz and calcareous-spar frequently occur together; and the form of the crystallization of the calcareous-spar is generally impressed on the quartz. Calcareous-spar and calcedony are often associated together in the same cavity. These balls of agate are completely insulated in the bed, and in general are separated from the rock by a thin film of green earth or clay, so that with a blow they are readily detached. When in a state of decomposition, the different concentric zones separate like the coats of an onion, each exhibiting all the features of a perfectly hollow sphere.

The structure of this bed of amygdaloid, leads to the conclusion, that while a general disposition to stratification prevailed in the aqueous menstruum, there existed a number of partial spheres of aggregation. Thus, while one portion of the fluid was depositing grains of calcareous-spar and quartz, and enclosing these with wacke, claystone or felspar; another portion was depositing basalt, clinkstone and greenstone, together with nodules of flint, jasper, and calcedony, in the form of agate-balls.

It appears evident from simple inspection, that these agates must have formed a part of the original composition of the rock, as the vesicles in which they occur, are in many places so numerous, that if empty, the rock could not sustain its own weight, much less the pressure of the superincumbent strata. Had these agates acquired their form and structure from fusion by means of heat, the soft clay which often encloses them, and in many cases fills a portion of the same cavity, must have been melted at the same time, and the friable enclosing rock would now have exhibited in its superior induration some of the marks of igneous influence; yet the clay continues loosely aggregated, and the enclosing rock, even where in contact with the agate, can be scratched with the nail. Besides, had these balls of agate ever been in fusion, we could not have expected to find, as we frequently observe, the fusible crystals of carbonate of lime impressing their form on the almost

infusible quartz, nor a large empty cavity occupying the centre of the mass.

The Wernerian hypothesis, which supposes these agates to have been formed by infiltration subsequently to the deposition of the bed, is equally liable to objections. Passing over the difficulty of accounting for the origin of these cells, by the extrication of air from the rock during its formation, we cannot conceive it possible for any flinty solution to have transuded through the pores of the soft bed on its way to fill the empty vesicles, without depositing some siliceous matter in these, and giving to the rock a greater degree of consolidation than it is known to possess. No umbilical cord of agate exists to point out the infiltration opening. And it is no uncommon thing to observe, in the same vesicle, a number of spherical concretions composed of concentric coats, and all enveloped in a continuous covering of agate, and surrounded with a crust of green-earth or iron-shot clay.

These facts, in the history of agate-balls, prove their simultaneous formation with the rock in which they are enclosed. They in this respect resemble the reniform ironstone which occurs in slate-clay, and the globular masses of flint imbedded in chalk. These three phenomena have so many points of resemblance, that any theory formed for the explanation of one of them, ought

to explain the appearances exhibited by the others.

There are no Veins of any consequence traversing the strata of this district. Veins of calcareous-spar and heavy-spar do occur, but present no circumstances in their history deserving of particular notice.

The rocks of the Redhead, appear to belong to the *old red sandstone* formation of Werner. This formation stretches across the island from the western to the eastern sea, and flanks on both sides the Grampian Mountains. On the south bank of the Murray Frith, it commences near Speymouth, and stretches towards Nairn, and includes valuable beds of limestone, as at the Bridge of Findhorn and Inverugie near Duffus. The limestone, at the latter place, contains a considerable quantity of lead-glance, and irregular masses of flint and calcedony. On the eastern coast, it commences near Stonehaven in Kincardineshire, and extends to the River Eden in Fifeshire. The southern boundary extends westward by Cupar, the north side of the Lomond Hills by Kinross, Alva and Kippen, towards Dunbarton. In the red sandstone of this district, are included many subordinate beds of porphyry, greenstone, claystone, clinkstone, compact felspar, amygdaloid, trap-tuff, slate-clay, and limestone. The rocks

which I have described*, as occurring in the neighbourhood of Dundee, form a portion of this district; and the Hills of Kinnoul and Moncrieff, near Perth, and the extensive range of the Ochils, all belong to the same formation with the red sandstone, and occupy a place in it in the form of beds.

The relations of the red sandstone of this district, with the older and newer rocks, are very distinctly displayed. At its northern extremity, Colonel Imrie, in his valuable section of the Grampians from the plains of Kincardine to the summit of Mount Battock, has traced its junction with the transition rocks on which it rests. At its southern extremity in Fifeshire and Clackmanan, it is covered with the strata belonging to the independent coal formation. This fact of the red sandstone being the fundamental rock of the coal-field of the Forth, was first pointed out to me by a very intelligent observer, Mr R. Bald of Alloa, with whom I had an opportunity of examining that part of the Ochils, on which the Clackmanan coal-field rests, in the month of September 1807. I had previously been convinced, that the independent coal formation was newer than the red sandstone, from an examination of the coast of Renfrew and Ayr, (May 1807,) as I observed a

* Page 138. of this volume.

junction of the two formations at Ardrossan Harbour, where the strata of red sandstone stretch nearly north and south, and dip to the east at an angle of about 30°. Over these strata of red sandstone, are deposited beds of white-coloured sandstone, slate-clay, limestone, slate-coal, clay-ironstone, and greenstone. These are unconformable, as they stretch from east to west, and dip to the south. Near the line of junction, the newer strata are much inclined, but they approach nearer to the horizontal position, as they recede from the red sandstone *.

The coal-field of the Forth, seems to rest in a cavity of the red sandstone, with which it is surrounded. On the north, it terminates at the red sandstone district of Fifeshire, and on the south, it is cut off by the same rock at Tranent; the red sandstone there appearing, stretching eastwards by Haddington and Dunbar, westwards to the Pentland Hills, and south to the transition country of the Lammermuir, where it ceases. Be-

* In the red sandstone, no beds of coal have hitherto been discovered in the middle districts of Scotland. Mr MACKENZIE, in his Mineralogy of the Ochil Hills, (Mem. Wern. Soc. vol. ii. p. 8.) mentions a bed of coal, as occurring under a red sandstone, near the King's Seat; but this sandstone, I have reason to believe, is a member of the regular coal-field, although situated at the base of the Ochils.

tween Haddington and Dunbar, the red sandstone contains beds of limestone and clinkstone-porphyry, and probably the other trap rocks occurring in that neighbourhood, and considered at present as members of the newest flœtz-trap formation.

Manse of Flisk, Fifeshire,
7th December 1814.

XXIII. *Description and Analysis of a Specimen of Native Iron found at Leadhills.*

By Mr H. M. Dacosta, M. W. S.

(Read 25th November 1815.)

This specimen of native iron, was found at Leadhills in Lanarkshire, associated with galena. The history of its discovery, is as follows: The miners, on dressing a quantity of ore, were surprised to find, that a portion of it resisted repeated blows of the hammer; this circumstance led them to examine it more particularly, when it proved to be a particular substance, which they immediately carried to the mine-master, Professor Irvine. I am told it is the second specimen of this rare mineral, which has been met with at Leadhills. Through the politeness of Professor Irvine, I am enabled to present it to the Society.

External Characters.

Its colour is intermediate between steel-grey and iron-black.

It occurs massive.

Its lustre is metallic and shining.

The fracture is small-grained, uneven.

It is opaque.

It is malleable, but not in a high degree.

It scratches glass.

Specific gravity, 7.07. Mr ADIE.

It is highly magnetic.

Chemical Characters.

It fuses at a white heat, with a lambent blue flame on its surface.

It becomes soft when heated, but does not recover its original hardness on cooling.

Analysis.

It is needless to repeat the experiments, shewing its negative chemical qualities. The following are the principal features in the analysis.

A. Eighteen grains of it heated gently in dilute muriatic acid dissolved slowly, giving out hydrogen gas, slightly impregnated with sulphur.

B. One grain of a dark powder remained, which resisted the action of boiling acids. This was

fused with pure potash, when it dissolved in water, depositing pure silex on the addition of muriatic acid.

C. Into the solution A, with excess of acid, pure ammonia was poured in excess, (after having ascertained that it neither contained copper nor lead); a precipitate was procured, which, when heated in contact with the air, weighed 37 grains.

D. The filtered solution C, did not give the slightest indication of metallic matter to hydro-sulphuret of potash or tincture of galls. Not a trace of nickel or magnesia could be discovered.

A similar quantity was fused to dispel volatile matter, and dissolved in dilute nitric acid, which it did with great rapidity, and the copious evolution of nitric oxide. The residue was boiled in muriatic acid, which dissolved all but one grain, which proved to be silex. The same process was followed as with the first portion, and with the same results, except the loss of $\frac{6}{10}$ of a grain. It is therefore iron, nearly pure, consisting of

Iron, -	$16\frac{1}{2}$
Silex, -	1
Loss chiefly sulphur about,	$0\frac{1}{2}$
	18

XXIV. *Mineralogical Observations in Galloway.*

By Dr Grierson.

(Read 20th January 1816.)

The internal structure of the globe, pretty early attracted attention. On penetrating its surface to obtain the useful minerals, the singularity of some appearances could not fail to be observed. Shells and other organic remains, were discovered in situations where they could not previously have been expected. It was natural thence to speculate on the manner in which these bodies should have come there; for to suppose them to have been always so, or to have been originally created in the state of waste and decay, in which they were then found, seemed too absurd to be admitted. This would have been equally unphilosophical as to have supposed, that our present peat-mosses were originally created full of

those decayed and half-rotten trees, with which we now find them to abound.

Something, therefore, it was necessary to devise, in order to afford at least a plausible explanation of the above and other similar phenomena. Theories in abundance, have been from time to time proposed, and have all had their day of vogue and admiration. But how few of them have been any thing else than mere fancies, or hypotheses proceeding on by far too narrow an induction of particulars. Indeed, it would not be going too far to say, that the greater part of them have been purely gratuitous suppositions. What else can well be affirmed of the celebrated theories of BURNET, BUFFON, and many others?

The subject is abstruse and difficult, and the theorists have been adventurous. We are still probably very far from a true theory of the earth, or a knowledge of the real cause or causes of geological phenomena. Nor is it very unlikely, that this knowledge may for ever elude our research, and that we may seek in vain for the actual manner in which the internal structure of our planet was produced. The bodies about which we reason, are in most cases concealed from our view; and it is only incidental glimpses of them, as it were, that we are able to obtain. It is only where the sea, or rivers, or mines, or quarries, have laid bare the rocks; or where they are naturally exposed on the brows of mountains, in

ravines, or precipices, that we are able to examine them. Every geologist knows, that the points in which we can see and examine the rocks which constitute the crust of our globe, bear hardly any proportion to those from which we are altogether excluded, either by the ocean, or the soil which covers the earth, and, unfortunately for the science of geology, but fortunately for the existence of geologists, renders it a fit habitation for vegetable and animal life. Of the central parts, I believe, it must be confessed, that, in a geological point of view, we know little or nothing. What, then, shall we say of those, who, without having seen or examined one-millionth part of the earth's surface, and certainly none of its central parts, take upon them to affirm, that such and such were the means by which it was brought into its present state, and that such and such agents exist and act in its central regions?

Of all the theorists of this sort, or intellectual adventurers, as we may call them, the late Dr Hutton of Edinburgh, was certainly the boldest, and the celebrated Werner of Freyberg, is, I think, the most modest. The former took upon him to account, not only for the present appearance of the earth, but for all the revolutions it had undergone in time past, as well as for all those it would undergo in time to come. He assumed as a cause, an agent of whose existence he could give no satisfactory proof, and of whose

existence many have thought they could demonstrate the impossibility.

WERNER, on the contrary, took induction for his guide. He did not first form a theory, and then examine the mineral kingdom for its confirmation; but he examined this kingdom, and thence drew a theory. He did, in short, for mineralogy what LINNÆUS had done for botany, and NEWTON for general physics. His first object was to distinguish, group, or arrange simple and compound minerals in cabinet specimens, according to their constant and most easily ascertained properties, and to introduce into the science a precise nomenclature. His next object was to trace the manner in which the rocks and other substances forming the crust of the earth, were placed with respect to one another; and to ascertain whether nature here, as in other parts of her works, observes a regular system of arrangement. He found that she does, and that there is a regular system of arrangement among the mineral masses of the globe on the great scale. This part of the subject, he distinguished by the name of *Geognosy*, —a new science, entirely created by him, and which is nothing more than the inductive philosophy of BACON, applied to the subject of geology.

Having ascertained the nature and arrangement of the substances constituting the crust of the earth, WERNER next ventured to speculate on the

manner in which they had been formed; and here, it must be confessed, that his conclusions are not always satisfactory. But while we admit this, we are at the same time prepared to maintain, that they are legitimate so far as they go, and afford, by much the most likely explanation that has hitherto been offered. The unsatisfactoriness of the theoretic conclusions of WERNER, arises not from the false and erroneous principles on which he proceeds, but from the difficulty of the subject, and the yet imperfect state of our induction. His opponents, themselves, have in effect been compelled to admit this, and have acknowledged, that "though he has not put us right, he has put us on the way of being right," or has shewn us the proper mode of investigation in this subject,—a merit of no slight kind certainly, and in the highest degree honourable to the man who has had the good fortune to attain it. To set us on the right road, is doubtless the first step towards enabling us to reach the place of our destination.

Proceeding on his principles, WERNER's now numerous and widely scattered pupils have for these last thirty years been making rapid strides in geognosy. It is not much above the half of that period, since the science was, we may say, at all known in this island; and yet, by the genius and enterprize of many of the members of this Society and others, and particularly of our Pre-

sident, a great deal of the country has been explored. We are already approaching a competent knowledge of the structure of the British Isles.

The purpose of this paper, is to attempt, in as far as my slender ability and information will permit, to promote the further progress of this very desirable object. I some time ago, and before having had the honour to be a member of this Society, was flattered, by the approbation it was pleased to give, of a short paper of mine, read before it by the President, on the Extent, Nature, Position and Connection, of one of the Granite Districts of Galloway. At present, it is my intention to detail a few observations, which I have since made on another of these districts. It is known that there are three of them, and that in all, the granite is at no great distance from the transition-rocks. It would, however, in the present state of our knowledge, be unwarrantable to say, that it is transition-granite. For though, at no great distance from the transition-rocks, yet, in only one place, viz. on the Burn of Palnure, as mentioned in my paper formerly alluded to, did I perceive the grey-wacke in actual contact with the granite. In all the other places, in so far as I have seen or heard of, there intervenes another rock betwixt them, totally different from either. But though the grey-wacke seemed to me to be in

contact with the granite in the Burn of Palnure, a little way below Craigdews, yet the former evidently rested on the granite, and not the granite on it.

I formerly found the middle granite district of Galloway, to consist of a nearly uniform mass of this rock; the felspar in general of a greyish-white colour, though in some varieties flesh-red, the mica black or brownish-black, and the quartz of the usual colour. No appearance of stratification; the highest mountain of the district, Cairnsmuir of Fleet, rising to the height of 1737 feet above the sea level, and the whole district ten miles long from north to south, by about four broad from east to west. The strata of the stratified rocks in the neighbourhood, I found not to wrap themselves round the granite, or assume the mantle-shape, but to run all in the same general direction, viz. from north-east to south-west, and to dip away from the granite on both the east and the west side. I also, as before noticed, found, that every where that I could observe, except in one place already mentioned, there intervenes betwixt the transition-rock and the granite, another rock, consisting of felspar, quartz, and mica, in a very compact form, and denominated by Professor Jameson, Compact or Fine-grained Gneiss. This compact or fine-grained gneiss, is in some places observable of a very great thickness. In one place, I saw it at least a mile from the gra-

nite, but in other places it extends to only a few feet.

The westernmost granite district of Galloway, or what has been called the Loch Doon one, is separated from the middle or Dee district, by about four miles of transition country. I was anxious to know, whether in this district, also, the same phenomena were observable that I had before found in the other which I had examined. With a view to ascertain this, I left Brockloch on the 1st of September last, in company with Mr Macmillan of Holm, to whose obligingness and hospitality, I had been several times before indebted, and proceeded north-westward over a high range of transition hills, four miles towards Loch Doon. On coming into sight of this fine lake, which we here did at a considerable elevation above its surface, we could not avoid being struck with the wild grandeur and beauty of the prospect. The forenoon was fine,—few clouds in the sky,—and the air nearly still. Before us lay Loch Doon, stretching away toward the right in a serpentine line for nine miles, and beyond, to the N. W. in the distance, the rich county of Ayr,—the sea,—the Rock of Ailsa,—and the Isle of Arran, appeared. To the south, or on our left, and as it were beneath our feet, lay the upper end of Loch Doon, overhung by the steep and high mountains of Knockour, Lamlach, Corran, and Merrock, the latter greatly the most elevated

of the group, and supposed by Mr MACMILLAN to be the highest land in this quarter. It is probably not less than 1750 feet high. The valley at the head of Loch Doon, is wild, and bleak, and sterile. No wood: heath and rocks almost solely appear to occupy the ground. A northern exposure; four human habitations only to be seen, and these merely thatched huts.

In an inland, stands the Castle, a ruin, interesting from the wildness of its situation, and the antique simplicity of its appearance. It is of no great extent, and appears, like most of the old Scottish castles, to have been little more than a single tower. The island on which it stands, is a bare granite-rock, of fifty or sixty yards in diameter, and which, the lake after a large fall of rain, or on the melting of the snow in winter, sometimes nearly overflows. The lake itself, as already stated, is nine miles long, stretching from about N. N. W. to S. S. E., and is in some places nearly half a mile wide. It has no island of consequence, except that on which the castle stands, nor is there a tree or bush to be seen along its banks,—one wild scene of heath and bare rock. It has salmon, trout, pike, perch, and eels. It is not deep, readily freezing over by a night or two's frost. It was, however, a good deal deeper formerly than it is at present. For in the year 1790, the Earl of CASSILIS, and the late Mr MACADAM of Craigengillan, the proprietors on each side, by a cut

or tunnel driven through the rock, over which its waters were discharged at the northern extremity, took nineteen feet from its depth. The object was to gain ground on its banks. But though many acres of surface, have in this way been obtained, they are in general but of little value, being mostly barren sand or gravel, or rolled pieces of rock of considerable size. The rock through which the above-mentioned cut or tunnel is made, is grey-wacke; and hence issues the "Bonny Doon," whose "banks and braes" have been rendered classic by the immortal lays of our Scottish Bard.

1. On proceeding, as I already mentioned, along with Mr Macmillan from his place at Brock-loch, distant from Loch Doon Castle four miles to the east, we came upon the junction of the granite with the stratified rock on the western face of the hill of Knockbour, about a mile to the east of Loch Doon Castle. The stratified rock here, in contact with the granite, is the same as I uniformly found in contact with it in the Dee district, (except in one place), and is fine-grained or compact gneiss. The strata are vertical, and the direction is N. and S. Where we made this observation, the ends of the strata run flush on the granite.

2. My next observation, was on the banks of the lake, still on the east side of it, not far from opposite the castle. Here is compact gneiss ver-

tical; direction as before, N. and S., touching the granite.

3. One mile north of the castle, compact gneiss, vertical; direction N. N. E. Do not know how far from the granite.

4. About 100 yards farther north, on the banks of the lake, vertical strata of compact gneiss; direction N. N. W., within about 120 yards of the granite.

5. The junction of the granite and gneiss, evidently crosses the lake about this place, running in an oblique direction towards the castle. To this, we now proceeded in a boat, and I found in the island on which the castle stands, on the south side, a mass of flesh-red felspar-porphyry, about 12 feet long by 3 feet thick, vertical as far as I could judge, (for this from its being about even with the granite all around, is not easily determined), and running N. N. E. From its direction merely, I should call it a bed rather than a vein.

6. I now proceeded to the west side of the lake, and found on its banks, to the S. W. of the castle, granite veins in abundance; or granite and compact gneiss alternating a vast number of times, and running in all directions on the nearly horizontal surface of the rock, laid bare by the waters of the lake. Some of these veins, or alternations, were three feet thick, and from this downwards to less than an inch.

7. About 400 yards farther down the lake, to the N. W. of the castle, at a sort of knoll, called Millgoan, I found the same appearances as at the former place. Compact gneiss running N. and S. with the granite mixed in it as before. I could not here determine the dip of the strata. I think they are nearly vertical, as they appear all to be about this place.

In the granite of this district, I noticed a phenomenon, which I had little opportunity of seeing in the Dee district. There, indeed, I had observed it in a few instances, and on a very small scale; but here it is common, and its features prominent. I allude to fragments of compact gneiss occurring in the granite. I observed one of these fragments of a tabular shape, two feet long, about ten inches broad, and four thick. Some of them have disintegrated more rapidly than the granite in which they appear imbedded, and so have left hollows in it, and have indeed fallen out. Others of them have weathered more slowly than the surrounding granite, and are seen projecting from its surface. I could not observe any instance of this rock (the compact gneiss) either in the strata or the fragments alluded to, passing into the granite, unless the manner in which this rock and the granite unite, be called so, which is in as distinct, but at the same time intimate a manner, as the alburnum or white wood of the oak, unites with the real or red wood. The termination of

the one, and beginning of the other, is seen distinctly, but the mass is equally strong at the junction, as any where else.

The granite here, is of much the same texture as in the Dee district; the felspar greyish-white, sometimes flesh-red; and the grains both of it, and the quartz, about a quarter of an inch or less in diameter. The mica, black, or brownish-black. Some varieties contain hornblende, but I did not here observe any shorl.

Having made these observations on the north end of this granite mass, I wished to see also how it met the transition country on the south. And for this purpose, on the 6th of September, set off in company with my friend Mr Macmillan of Viewfield, near New Galloway, whose obligingness, intelligence, and zeal, in these sort of pursuits, I cannot too highly acknowledge.

8. We first found the granite about eleven miles west of New Galloway, on the western side of the hill of Little Millyea, about half way down the hill, one mile and a half to the N. E. of Loch Dee. Here, in as far as could be observed, it appeared to be in contact with compact gneiss, in so much, that though I did not expect the granite for more than a mile farther on, I observed to Mr Macmillan, that now we must be near it, for I perceived, we had come to the rock which always lay upon it, and in a few steps farther we

found the granite. It is here, however, so much covered up, that no junction can be seen.

9. In a rivulet that descends from the mountain, and falls into the Burn of Carnelloch, about a quarter of a mile to the S.E. of the spot first mentioned, we observed a bed of reddish felspar-porphyry in the compact gneiss, at the least twenty-five feet thick. I could not certainly determine its dip, the strata around it being so much covered up. All these in the above-mentioned mountain of Millyea, run in the direction N.N.E. highly inclined, or nearly vertical.

10. In this quarter, we could observe no other junction of the granite with the stratified rocks; but in the Burn of Carnelloch, one mile N.E. of Loch Dee, is a bed of bluish felspar-porphyry in the granite. The direction of this bed, is S.E., and it appears to be nearly perpendicular. It is traceable along the channel of the burn for more than 400 yards, and is in some places 30 feet thick. The boundary of the granite seems to run along the west side of the Millyea, about half way up the hill.

11. Proceeding onward in a southerly direction towards Loch Dee, we saw no rock but granite, till we came to the Cooran Lane, a considerable stream, which, proceeding from the west, falls into the Dee about half a mile after the latter has left its source the Lake of Dee. Into this Cooran Lane, the before-mentioned Burn of Carnelloch

falls. In the bed of the former, three-fourths of a mile north of Loch Dee, we found in the granite, a large bed of reddish felspar-porphyry, 40 feet thick, seemingly vertical, and we traced it at least 60 yards. Its direction is S. E. by S.

12. One mile farther down the Cooran Lane, we came upon another bed of felspar-porphyry in the granite, to be seen for 30 yards. Its direction is about S. E. by S., apparently vertical.

13. Several yards farther down still, is another bed in the granite, seemingly in the same direction.

14. In the first small rivulet we came to, falling into the Dee on its left bank, we found another bed of reddish felspar-porphyry in the granite, lying in the same direction as before, and to all appearance vertical.

15. Two miles nearly below Loch Dee, that is, down the river to the eastward, opposite a small burn on the right bank of the river falling down the Hill of Craigencaillie, and another on the brae face of the low Hill of Garrery, is the junction of the granite and the stratified rock. It runs directly across the river, and is distinctly to be seen. The rock here, resting on the granite, is compact gneiss, of many yards in thickness, and the strata vertical. The direction is E. N. E. I could neither here, nor any where else in this quarter, perceive a junction of the compact gneiss with the grey-wacke.

Loch Dee is a wild mountain lake, out of which the River Dee issues, about 15 miles to the S. S. W. of New Galloway. It is a mile in length, and perhaps about half as much in breadth. Its immediate banks are low and flat, consisting principally of peat-moss covered with heath; but to the W. and N. W., at a few miles distance, rise the Hills of Glenhead, Buchan, and Merrock, to the height of 1000 to 1700 feet or more. On the east of it, is the Hill of Craigencaillie, and to the north, Millyea. The lake itself, is of no great depth, for it easily freezes over. I had no means of fathoming it. It contains salmon, trout, pike, perch, and eels. The scene around is as wild and bleak as can well be imagined. Nothing to be seen but heath and rocks. No human dwelling within view. Betwixt this lake, and that of Doon, is eight miles, and this appears to be about the extreme length of the Doon mass of granite. West from Loch Dee, runs Glentrool, where the granite probably terminates toward the south. I regretted not being able to explore this glen. Mr Macmillan informs me, that it is bold, beautiful, and romantic.

As already observed, the river Dee issues from the above-mentioned lake or loch of the same name; takes a south-easterly direction, and, after a course of 18 miles, loses itself in the Lake of Ken,—at the beautiful seat of Airds, six miles S. E. by S. of New Galloway. In its course, it

traverses three times the junction of the stratified country with the granite, the eastern junction of the Loch Doon mass, as I have already stated, near Craigencaillie, and both eastern and western junctions of the Dee mass, viz. the western junction at the Bridge of Dee, and the eastern one at the east end of Strone Loch, about four miles farther down, as I formerly described in my account of the Dee district.

The distance betwixt the western junction of the Dee granite district with the stratified country at the Bridge of Dee, and the junction of the Doon district on the east, with the stratified rock at Craigencaillie, is four miles, and these appear to be about the nearest points of distance betwixt the two masses. I regret that I have not had it in my power to make the entire circuit of the Doon granite, so as to ascertain its mode of junction with the stratified country on the western side also. I should then have been able likewise to have ascertained more accurately its extent. But as to the latter, we are pretty well informed, seeing we have an account of it from Sir James Hall, who made the above circuit in 1790, as he informs us, in his paper "On the Convolutions of Strata, and their meeting with Granite," published in the 5th volume of the Transactions of the Royal Society of Edinburgh: he found it to be about eight miles by four.

No part of this granite mass, appears to rise quite so high as the other two Galloway masses do, namely, in the Mountains of Cairnsmuir and Criffle; for Merrock, the highest mountain in this quarter, appears to be transition. I say so, however, merely from a distant view of the mountain, for I was not at it. There is much more verdure on Merrock, than is usually seen on granite hills, and its rocks are of a redder hue than the granite of this quarter puts on. But if Merrock be not granite, it must be immediately on the border of the Doon granite on the west.

This mass of granite, appears to bear the same sort of relation to the stratified country, as I formerly found the Dee mass to have. The grey-wacke, or grey-wacke-slate, no where that I could see, comes into contact with it, but is every where separated by the compact gneiss, and the strata of this rock observe the usual direction, not varying above four or five points; and their ends on the N. E. side of the granite, run directly towards it. On the east side of the granite, they meet it in a conformable position, and are either vertical, or dip from it. They are much more highly inclined than those which meet the Dee granite.

The Doon granite in general, is of the same texture with that of the Dee, but there are two peculiarities with respect to its relation to other rocks, which are observable. One of these, I have already described, namely, the occurrence of frag-

ments of gneiss in the granite; and the other is the occurrence of beds of felspar-porphyry in it. A small one of these has been described, as seen in the island at the Castle of Doon, and no fewer than five were observed by us towards the south end of this granite district near Loch Dee. Some of these beds are very large, of equal dimensions, and of the very same structure and appearance with the beds I described in my former paper, as seen in the transition rocks of the valley of Glenkens. I could in no place observe this porphyritic rock passing into the granite. It seemed in every place to meet it distinctly and abruptly. In some places, the two rocks, at their junction, seemed not even to adhere.

From the general appearance of the granite, and its relations to the neighbouring rocks, it appears to belong to one of the newer formations.

XXV. *Lithological Observations on the Vicinity of Loch-Lomond.*

By Dr Macknight.

(Read 13th March 1813.)

This district has long been celebrated for the beauty and grandeur of its natural scenery. Many descriptions of its interesting features, are in the hands of the public; and it has furnished a variety of favourite subjects for the pencil. But no proper account of its mineralogy has yet been given. To supply this defect, in some measure, is the object of the following observations, although they are, I fear, but little deserving of the Society's attention.

Loch-Lomond stretches nearly in the line of north and south, from its highest point in Glenfalloch, to the village of Luss; opposite to which, on the east and south, it expands to a great

breadth, and presents those scattered groupes of islands, which render its appearance so extremely beautiful and picturesque. The portion of its neighbourhood which I examined, begins on the east side, about two miles south of Row Ardennan, and terminates at the north-west extremity of the base of Ben-Lomond, opposite to Tarbet: On the south side, it reaches from Tarbet to the head of the Leven. In this district, the rocks which occur along the margin of Loch-Lomond on both sides, form a regular and complete series, from the older mica-slate, to the newer species of grey-wacke; including several subordinate beds and minerals, and followed by different sandstone formations, which compose the lower country, on the banks of the Leven, towards Dunbarton.

Before proceeding to describe the particular localities and relations of these rocks, it is proper to notice, that the general structure of the country in this quarter corresponds to what is found throughout the whole of the Highlands, where mica-slate is the prevailing rock. The mountains and hollows appear to be formed by the irregular effects of decomposition and waste on the mass of alpine strata, which runs in the direction of N. E. and S. W. Thus, at the summit, and along the sides and base of Ben-Lomond, the strata of mica-slate are distinctly observed cropping out in the usual direction, and in a position

almost vertical; from which it may be inferred, that they compose the body of the mountain itself. And Loch-Lomond is in fact, a vast hollow scooped out of the same rocks; for the strata on the west, are found to be only a continuation of those observed on the opposite side. In like manner, the islands are formed by the same rocks which occur on the mainland, in the general direction already mentioned: so that the whole must have originally constituted one great mass or line of strata, which has been broken or worn into its present shape.

Ben-Lomond, which, viewed from certain positions, has an uncommonly noble and majestic appearance, rises to the height of 3200 feet. It is composed of mica-slate, passing frequently into talc-slate, and intermixed with vast beds of felspar-porphyry and greenstone, which lie in a position conformable with the strata of the including rock. In this species of mica-slate, there is much quartz; particularly, towards the summit of the mountain, the rock appears remarkably penetrated and traversed by that substance, in veins and masses of every size and form. Indeed, it is found to be the prevailing ingredient throughout the whole formation, and often gives the mica-slate a whitish colour, resembling at a distance that of pure quartz. I did not, however, observe quartz in regular beds.

About a mile from Row Ardennan, on the road to the summit, we meet with a rock approaching to greenstone, and containing pyrites. It is disposed in a conformable bed of great thickness, which may be traced penetrating the base to a considerable distance. Along the ascent, there does not seem to be much variety in the rock. At the summit, it is pure mica-slate, resembling that of Benmore, and assuming the form of a sharp serrated ridge.

The mountain here, has a great precipice on the N. E. side, with the same indented angular hollow, of which so many examples occur in the Highlands. It is a scene of rude and awful grandeur, in the fore-ground of what is generally mentioned as the finest prospect in Scotland; and were it not a subject already exhausted in the pages of travellers and describers, a new visitor, who is lucky enough to reach this interesting elevation under a favourable sky, might still be tempted to indulge his feelings of admiration and delight, in producing a picture of the numberless beautiful and striking objects which present themselves in every direction. The position, indeed, of so lofty a mountain, on the edge of the Highlands, and skirted by such a magnificent sheet of water, is peculiarly favourable for a commanding and picturesque view both of the alpine and of the low country.

The N. W. shoulder exhibits quartzy-mica-slate, tending to gneiss, which probably occurs at no great distance in this direction. This species of mica-slate, is unusually undulated, and its structure affects a greater variety of singular and fantastic appearances, than any I have met with. It is also remarkable how much the layers of the stone are affected by the intermixture of pure quartz.

Examining the base, which is thickly covered with brush-wood and debris, to the north of Row Ardennan, I found two beds of felspar-porphyry; but the existence of many more is ascertained, from numerous blocks and fragments of that substance, scattered at certain distances along the shore. The mass of this rock is much penetrated with hornblende, chlorite, and crystals of pistacite, generally crossing one another in pairs, like the shape of an X. These last are very numerous even in the smallest detached specimens, and produce an uncommon effect to the eye. There are also vast strata of porphyritic mica-slate, thickly studded with crystals of quartz, particularly one, which may be observed near a cottage on the side of the Loch, about 2½ miles N. E. from Row Ardennan. Its structure seems precisely the same with that of an extremely hard and indestructible kind, formerly described*, at

* Wernerian Memoirs, vol. i. p. 287.

the side of Loch-Katterin; and it is probably of the same formation, as this substance may be traced for many miles in the general direction of the strata along the intermediate country.

On the west side of Loch-Lomond, between Tarbet and Luss, mica-slate, talcky, and talc-slate, with beds of greenstone and felspar-porphyry, are found occurring in the same order of relative position, and with the same oryctognostic characters, as the beds and strata already noticed in the structure of the mountain and its base: so that, comparing the distances and positions of the corresponding rocks on each side, in the general line or bearing of the strata, we perceive that they are parts of one formation.

Southward of Row Ardennan, the mica-slate approaches to, and passes into clay-slate, and also alternates with it. Clay-slate is found in the bed of a stream called Cullimore, which forms the southern extremity of the base of Ben-Lomond. Amongst the rocks in this direction, the most remarkable are two beds of felspar-porphyry, about half a mile from Row Ardennan, which may be traced to a great length, running from the water into the high ground parallel to each other, and separated only by a narrow stratum of mica-slate. This stratum appears to maintain the same breadth, so far as it is possible to follow the rocks; and along with the two beds, by which it is inclosed, lies conformably with the other strata in its vici-

nity. The porphyry contains crystals of hornblende and pistacite, with small portions of chlorite, and occasionally common garnet and pyrites. It also frequently affects a slaty structure.

In the same direction, the clay-slate is succeeded and covered by grey-wacke, and grey-wacke with a slaty fracture; both of a peculiar composition, and probably alternating with the older rocks. This substance is an aggregate of the usual fragments and materials, studded with blue quartz, common quartz, and crystals of felspar. It is found ascending to a considerable height above the level of the water, till it is lost under the heathy ground; but it re-appears in the bed of the stream above mentioned. I did not find grey-wacke-slate, properly so called. In this portion also, of the formation we are describing, the same predominance of quartzy materials, which was formerly noticed, is still remarkable, not only in veins and separate masses, but pervading the substance of the rocks.

The islands of Loch-Lomond, are placed in the line of clay-slate and transition-strata; and consequently, as already observed, are formed by the more durable varieties of these rocks, which may be traced in continuation, on the opposite shore around Luss. The quarries of Luss and Camstradden, in which the finest clay or roof slate is procured, are well known. They belong to the great formation of clay-slate, which has been

traced in so many places, skirting the Highlands from S. W. to N. E.

Near Rossdoe, we have grey-wacke, and a mineral approaching grey-wacke-slate. These rocks are succeeded, towards Glen-Fruin, by the old red sandstone, in which we observe fragments of quartz, clay-slate, flinty-slate, felspar, &c., and which occurs also intimately mixed with lime, so as to form a species of clay-limestone. It is seen cropping out on the road near Cameron, and continues to the neighbourhood of Dunbarton, where there seems to be a second sandstone formation, deeply coloured with iron-ochre. All these successive rocks descend in their level and out-goings, agreeably to the System, till we reach Dunbarton, at which the strata are horizontal, or nearly so.

In the course of this examination, which has added another example to the many illustrations already existing, of the Wernerian Geognosy, I found no traces of metallic ores; nor was I so fortunate as to discover any imbedded individual, or valuable minerals, worth remarking, so that, to judge from what occurred to my observation, this part of the Highlands is probably more interesting to the admirer of natural scenery, than to the mineralogist.

I shall now conclude this notice, with a remark or two, suggested by the phenomena of the rocks it describes.

1. The penetration of the rock by veins and masses of pure quartz, has been remarked. It is well seen in the clay-slate quarries; and it leads to the inquiry, whether the quartz, in the form of nests and small masses, belongs to the original structure of the stone, or is a foreign ingredient subsequently injected in a fluid state, by an external force acting from below. Now, although the whole phenomena may be difficult of explanation on either of these two principles, the one first mentioned appears to me the most natural; because the irregularity in the structure of the stone, which accompanies the occurrence of the quartz, is also to be observed not less frequently, where no separate portions of quartz are to be seen at all. It is a circumstance not a little favourable to this idea, that masses of quartz perfectly isolated may be every where observed, with the layers of the rock in which they are immersed, lapped round them, and obeying exactly the irregularities of their various shapes.

2. The internal structure of the pure mica-slate itself, furnishes another remarkable subject of theoretical discussion. Betwixt the layers, which observe the general direction of the strata, we find others in which the concretions are at different angles to the direction of the including layers, or follow waving irregular lines, in an endless variety of forms. At times, these layers

even bend into the contrary direction, and appear inserted concentrically into one another, in a kind of parabolic and conoidal shape. It is self-evident, that such a structure in stratified substances, could not have been the effect of any mechanical pressure or force acting with violence on the great scale, because the bent and straight layers alternate regularly with one another. Nor will it admit of being explained, by the hypothesis of desiccation after extreme heat. We can ascribe the phenomena in question only to the action of such natural powers, as silently and regularly affect the smaller particles or portions of matter, while assuming new forms of aggregation or minute crystallization, after having been deposited from a solvent. Other appearances of undulation in the layers, are manifestly those which would be produced in the course of deposition from a fluid affected by currents, or in a state of agitation, sometimes gentler, and at others more violent, as may be seen in the perpendicular section of any common sand-bank.

However, therefore, the question respecting the vertical position of the strata may be decided, the difficulty of accounting for the internal structure of the stone will still remain in all its force, and is equally great, whether the strata were formed originally in a horizontal position, or inclined as we actually see them. For, if horizontal, then

we are sensible, by a simple inspection of the figures, that the minuter concretions must have been formed in an inclined, or even, in many cases, a vertical position, and frequently also in a *bent* or *waved* line.

From these remarks, it would appear to be not improbable, that further discoveries may afterwards shew us, that other powers, in addition to those of gravity, or even chemical attraction, have been concerned in producing the appearances now presented. Is it not possible, that magnetism and electricity, lodged in the great central masses of the globe, may have performed a more important part, in affecting the arrangement of the materials deposited in the form of strata, than we are yet fully prepared to allow? And may not the action of a magnet on iron-filings, when a sheet of paper is interposed, as well as many phenomena of chemical and electrical attraction, convey some idea of what may have taken place at the period of such deposition?

If action of this kind might be admitted on the small scale, no difficulty would remain, in conceiving that nature on the great scale might have formed strata, as we now see them, *under any angle of inclination* to the horizon, more especially when modified by the form of the nucleus or substratum on which the deposition may be supposed to have taken place. In like manner, with regard to the *size* or *mass* of the strata, it is plain,

that if a layer of only a few lines thickness could be formed by the agents now supposed acting in directions different from, or opposite to, that of gravity, and thus modifying the effects of that power,—layers or strata, of any magnitude observable in nature, might have been formed in the same way. And unless this hypothesis be admitted, the appearances which have been described, must remain for ever inexplicable.

On the whole, the phenomena exhibited in the actual position, and internal structure, of the mica-slate of Ben-Lomond, may be quoted as an authentic and demonstrative record, attesting the reality of operations and events that have taken place at some former period in nature, by powers or causes, of which the action has not hitherto been recognized in our geological speculations.

XXVI. *Description of Ravensheugh.*

By Dr Macknight.

(Read 6th January 1816.*)*

In the following paper, I am to describe shortly a point of coast, which Professor Jameson, in his examination of East Lothian, had not an opportunity of visiting. It is called Ravensheugh, situated about six miles N. W. of Dunbar, and is part of the pleasure-ground belonging to the estate of Tyningham, on the north side of what are called Tyningham Sands. A small wooden summer-house is erected on the highest point of the rock, which commands a singular and extensive view of the surrounding ocean, and neighbouring country.

The approach to Ravensheugh, on the land-side, is gradual and insensible in its rise; but towards the sea, there is formed a precipice or precipitous front, which may be from forty to fifty

feet high. This projects into the shore in the shape of an obtuse angle, pointing nearly N. E.; and immediately behind the most prominent part of the rock, there is a considerable rent or chasm, lying in a direction W. of N., which, at full tide, when the sea is agitated, has a striking resemblance to the Bullers of Buchan, by the rushing and foam and noise of the water. On the south side of the point, there is another opening into the shore, which might suggest the idea, that the headland, or point itself, had been detached by violence from the body of the rock. I am satisfied, however, that these rents have been occasioned merely by the action of the water, on a part of the rock, where perhaps a slight subsidence had taken place, before it was entirely consolidated.

Ravensheugh is a trap formation of the newer series, apparently overlying, but in reality subordinate to, and contained in the old red sandstone. Its constituent members, are, basalt with crystals of hornblende; red and green trap-tuff, impregnated with lime; beautiful clinkstone; and clinkstone-porphyry, or porphyry-slate. This last occupies the upper part of the formation; and from the regular structure of the stone splitting in uniform parallel lines, exhibits an appearance like basaltic columns lying horizontally. The layers of rock thus formed, are from a few inches to a foot and a half, or two feet thick, and, con-

trasted with the irregular rude shapes of the great masses in which they appear, have a singular and pleasing effect to the eye.

The sandstone formation, on which the trap rests, and which forms the level part of the shore uncovered by the sea at low water, contains varieties of the old red, of different shades, alternating with layers of brown and grey. Particular portions of it have the usual characters of quartzy sandstone; others are micaceous, and approach to what is called sandstone-slate. In this formation, we also find beds or layers of clay-ironstone; of slaty argillaceous marl; of coarse limestone, with clay-balls of a greenish colour; and of claystone, inclining to calcareous marl, including nodules of light-yellow and green-coloured clay. Along the shore which was examined, and which extends for a mile and a half, or two miles, the dip and direction of these different beds or layers, are sufficiently uniform, excepting at the immediate junction of the trap and sandstone rocks, which presents an appearance extremely curious, and well entitled to the particular attention of the geologist.

Here the sandstone, deserting its usual dip and direction, seems to run beneath the basalt on every side, in the form of a vast cup or plate, filled with the solid mass of the trap, which rises upright from its edge. Consequently, the dip of the sandstone underneath the north side of the ba-

saltic rock, is nearly the reverse of what it appears to be on the south side. The explanation of this curious and interesting appearance, is easy and natural, if we consider the trap of Ravensheugh as a rock subordinate to the sandstone, and belonging to the same period of formation; but the peculiarity which has been described, seems to be altogether irreconcilable with the principles of the igneous theory. To perceive this, let us attend a little to what is meant by cotemporaneous formation.

It cannot be meant, that a whole mass of stratified or amorphous matter is *instantaneously* deposited; this appears inconceivable. But there is no difficulty in supposing, that layers or substances on the great scale, are formed by continuous successive accretion of matter deposited from a solvent, as we see in the instances of crystallization or deposition, which fall under our observation, either in nature, or in the laboratory of the chemist. Let us, therefore, now conceive, that, after the sandstone was deposited, but before its complete consolidation had taken plaoe, a mass of trap followed next in the order of successive deposition, What would be the consequence? Would not the superincumbent mass sink by its gravity to a certain depth among the softer strata underneath, presenting the very appearance observed at Ravensheugh,—more especially, if deposited,

as it is there, unconformably? Suppose a number of strata or layers of a tenacious paste, or any soft elastic substance, overlying each other, and

a heavy body of smaller dimensions laid above them, it is evident, that the weight of the body would press it downwards, and form a hollow corresponding to its shape, in which the layers would be seen bent, and running beneath the body on every side, exactly as we find in the present instance.

On the other hand, had this been a case of igneous bursting from below, all the phenomena must have been precisely the reverse of what they are. The strata, instead of sloping quietly beneath the mass, ought to have appeared as if forced up, with an inclination outwards from the projected rock, and with other symptoms of dislocation and ruin. But far otherwise, no marks of violence are to be observed. The out-goings of the subjacent rocks on every side, though worn down in very irregular shapes, preserve their usual line of direction without disturbance, to the very bottom of the basaltic mass; and it is even probable, that at some period not very remote, they had embraced the trap-rock to a much higher level than at present; all which, strongly favours

the idea of cotemporaneous formation, as here explained.

About a mile N. W. of Ravensheugh, there is another elevated rock, consisting chiefly of clinkstone and basalt, with crystals of hornblende, where similar appearances in relation to the underlying sandstone are to be observed.

XXVII. *Hints regarding the Coincidence which takes place in the Pressure of the Atmosphere, at different Latitudes, and at nearly the same Time.*

By the Right Hon. Lord GRAY, F. R. S. Lond. & Edin. &c

(*Read 23d November* 1816.)

THE annexed plate * contains the observations of the barometer for two years, 1814 and 1815, at four and three different places in Great Britain, from latitude 57° 38′ to 50° 26′. They are reduced into curves, the more readily to shew the great harmony which subsists in atmospherical pressure. I was first induced to think much on

* Plate xx.

this subject, by an article in the Annals of Philosophy, vol. i. p. 408, drawn out by Professor PICTET of Geneva, who furnishes the curves for one year at three places, viz. London, Paris, and Geneva. Being somewhat surprised at the general coincidence of those curves, I set to work to collect and reduce some series of observations which I had by me, in order to stir up inquiry, as it certainly appears very probable, that the pressure is almost simultaneous from the North Pole to the Equator: And I feel extremely anxious to ascertain, whether the same harmony obtains from the South Pole, and whether it shall correspond with those of our side of the line.

The only way in which this can be established, is by accurate observations kept at St Helena, the Cape of Good Hope, and Botany Bay. We should, by these, be able to see if there were any, or how much difference; which would tend very greatly to elucidate this most curious and interesting subject.

If this should attract the attention of any person engaged in meteorological pursuits in the southern hemisphere, who would take the trouble to send home the results of their observations for any year, directed to me at Edinburgh, I would

esteem it a very particular favour, and acknowledge it as such.

N. B.—The figures on the curves denote the day of each month, on which the extreme rise or fall took place.

Kinfauns Castle, near Perth,
6th August 1816.

XXVIII. *An account of several new and rare species of Fishes, taken on the south coast of Devonshire, with some remarks on some others of more common occurrence.*

By George Montagu, Esq. F. L. S. & M. W. S.

*(Read 20th May 1815 *.)*

Cartilaginous.

Raia.

There is no genus in the division of cartilaginous fishes worse defined, or less understood, than that of the Ray. This circumstance proceeds from several causes not generally known, except by those who have studied the subject at the sea-side, where opportunity has offered for the examination of a great number of specimens. Independent of numerous variations in colour and markings, to which some species are subject at all

* The author died in the month of July following.—*Editors.*

ages, there are some characters which do not always appear before a certain period of life. It is also deserving of notice, that sexual distinction should always be attended to, as it will be found, that, owing to the want of sufficient attention to that circumstance, species have been multiplied beyond their natural limits.

Having had an opportunity of examining some thousands of this class of fishes, either alive, or recently taken, amongst which, I noticed six or seven species, I am enabled to make the following observations.

The males are distinguished by their genitals, of a most curious structure, hanging pendent, one on each side of the tail, between it and the anal fins: the testes are inclosed at the base of these, not obvious but by dissection. What accompanies this truly masculine distinction, are series of large reclined hooked spines, never to be found on the other sex, and which begin to shew themselves early in all the species hitherto examined; these are placed in four distinct series, one on each shoulder or fore-part of the wing, or pectoral fin, and one on each angle of the wing. These spines are complete hooks resembling those used for fishing, and lie with their points reclined inwards in two or three, and sometimes four parallel lines, but the number of rows, and number in each row, depends on age; for in very young spe-

cimens, I have noticed only four or five spines in a single row *. These formidable spines, peculiar to the masculine gender, have occasionally been fixed on as a specific character; and as it does not appear to be generally known that it is only a sexual distinction, it has been thought proper to notice it for the advantage of others who may be pursuing the same track. There is another circumstance, which perhaps, in the discrimination of species, requires more attention than usual; that is, the teeth of both sexes of each species. The necessity of this, is particularly evinced by the great difference observable in the teeth of the two sexes of the Thornback, *Raia clavata*.

Having made these general observations, I shall proceed to notice some specific peculiarities under their proper heads, and to describe one or two species, which, if known, are not sufficiently defined to admit of synonyms. It may not perhaps be uninteresting, to remark in this place, the immense quantity of this tribe of fishes which are taken, and chiefly used for baiting crab-pots. It

* For what purpose this formidable armoury is given exclusively to the males, is not known, but as the hooks are extremely sharp, and lie partly concealed, with their points a trifle reflected, the fisherman's hands are frequently lacerated by incautiously handling the fish.

has been computed, that four boats employed in crabbing, consume in one season twenty tons of fish, principally Ray; but it is probable, not less than forty tons of Ray are brought on shore by the fishermen of the small hamlet of Torcross on the south coast of Devon in one season, besides what are consigned to the deep immediately, as useless.

When other fish are scarce, very small Rays are sometimes eaten by the families of fishermen, but never offered for sale, being considered by all classes in the neighbourhood as very inferior food; but dogs, pigs, and gulls, regale upon what are left to putrefy upon the shore.

The reason of this vast consumption of coarse fish in catching crabs, is, that they are extremely nice in the choice of their food, and will not enter the pots when the bait is the least tainted. In this particular, the crab differs from the lobster, which cannot be taken but by bait in a state of putridity.

Raia clavata.

In search of both sexes of this species, I was naturally led by the usually described essential character, of the teeth being blunt, and I was not a little surprised when, amongst several hundreds examined, not one male could be found;

but I noticed a Ray, not unfrequently taken with the Thornback, that was in every other respect similar, except that the wings were generally not so rough, and sometimes quite smooth about the middle. A variety also of this fish, had an oblong dusky spot surrounded with white, in the middle of each wing. The teeth of these fishes were not above half the size of those of the female Thornback, and, except a few of the outer series on the lips, were sharp-pointed. For a long time I was puzzled to discover, to what species of Raia these belonged, till, after an examination of a great number, I began to be as much surprised at not finding a female amongst such a quantity of these, as I was, at not finding a male amongst those with blunt teeth. These circumstances naturally induced me to conclude, that the sexes of *clavata* had not been accurately defined, and that the leading character of blunt teeth might have been drawn from the female only. The fishermen had not noticed the distinction of the teeth in these fishes, and had considered all of them to be Thornbacks. After much attention to the subject, and after having offered a premium for a male Thornback with blunt teeth, an intelligent fisherman assured me, he had examined a vast number since I pointed out the distinction of the teeth, and that he could not find one instance of a male with blunt teeth, nor a female with sharp teeth. It may therefore be fairly inferred, that

the sexes of the Thornback actually differ in this particular, and that the male has probably been described as a different species, but under what title, it is difficult to ascertain, unless it be Raja Fullonica of some authors. It will be recollected, that the large hooked spines on the wings or pectoral fins of this genus, have not been generally considered as peculiar to the masculine gender, and, therefore, are given as a specific character of the *fullonica*, and in fact, give origin to its name, from a supposed similarity to the instrument used by fullers for combing the wool. It will also be observed, that the Thornback has never been described to possess those reclined hooks. The species described by PENNANT for the Fuller's Ray, which he says is known at Scarborough by the name of White Haus or Gullet, appears to be very distinct, and there is little doubt, is the same as the fishermen on this coast call Land Ray or French Ray *. The Rough Ray, R. rubus, is probably only another variety of the male Thornback; for, as to the tubercular spines with which both sexes of that species are occasionally furnished on the lower surface, as well as on the upper, there is no dependence on them, since some specimens have none on either; others very sparingly above, and none beneath;

* Rubus, DONOVAN, Fishes, 1. tab. 20.

and it is only occasionally that many spines are observable on the under part. The spines on the tail of the Thornback, are equally subject to much variation, as I have noticed it with one, three, and five rows, and rarely without any; but the males have usually three rows, which is the number BLOCH, GMELIN, and some other writers, give to the Rubus *. The species captured by PENNANT in Loch Broom, and which he considered as the Rubus or Rough Ray, was entirely covered with small spines, (meaning, it is presumed, that spiny asperity with which the skin of many species is covered), equally above and beneath. If such is his meaning, it certainly does not belong to the Thornback, as neither that, nor any other species that has come under my examination, had the skin of the under part rough †. Dr SHAW says, the under part of the Rubus is beset with very numerous scattered spines, but less strong than those of the back; an expression, that does not convey the idea of a rough skin, but detached *aculei*, as we find occasionally on the Thornback. This naturalist expresses a suspicion, that the Rubus and Fullonica are only varieties of the same species. Had it not been for the teeth of

* Sometimes described with five.

† PENNANT says, the teeth were flat and rhomboidal, although placed in the division with sharp teeth.

the Rubus being sharp-pointed, and the supposition that the teeth of both sexes of the Thornback were obtuse, (a circumstance on which he seems to lay much stress), he would probably have pronounced it a male of that species. What strengthens the opinion that the Rubus of most authors is the Male Thornback, is the mention of the spines on the flaps of the pectoral fins, (a peculiar mark of the masculine gender), and that the colour agrees with that fish.

Having ventured to express doubts of any specific distinction between Raja clavata, rubus and fullonica of most authors, and that the sexual difference in clavata, has probably occasioned this error; I shall conclude the subject, with offering a conjecture, whether the Raia radiata, DONOVAN, *British Fishes*, v. tab. 114., may not be a young specimen of what some writers have called Rubus.

Raia chagrinea.

Chagreen Ray. Brit. Zool. iii. p. 87.—*Shaw*, Zoöl. v. p. 281.

Plate xxi.

This species, originally described by Mr PENNANT, from specimens observed at Scarborough, appears to be little known. It should seem that GMELIN, who has generally referred to the British Zoology, either accidentally omitted it, or did

not give our valuable countryman credit for it as a distinct species; and, what is more extraordinary, Dr TURTON, in his edition of GMELIN, also omitted this fish, though he afterwards introduced it into his British Fauna, and unfortunately, as the leading character, says, " the snout and tail with a triple row of spines." Dr SHAW, who, we may presume, was directed to this species by the British Zoology of Mr PENNANT, must have also strangely construed the description of that author, by saying, " *rostra caudaque* serie aculeorum triplici," characters that do not belong to this fish. Mr PENNANT particularly says, " On the nose are two short rows of spines," and " on the tail are two rows, continued a little up the back." He afterwards says, " Along the sides of the tail, is a row of minute spines, intermixed with innumerable little spiculæ." Now, it must be evident, had these last rows of minor spines been meant in the description of those writers, they must have called it four rows, not three. This error in the description of the leading characters, demands particular notice, because it deprives the species of the singularity that so strongly marks its distinction from all others of the tribe, that of having no row of spines along the ridge of the tail, which it must have possessed, had it been furnished with three rows. Mr PENNANT has well defined this species by the tail; for it has only two rows of larger spines, and these are placed on

each side the ridge of the tail, and project outwards, giving it somewhat the appearance of the snout of a Sawfish: these spines are much hooked backwards, and extremely sharp. As to the row of smaller spines on each side, they are indeed small, and scarcely definable as a single row, being intermixed with innumerable minute ones little inferior in size. In fact, the whole tail is covered with minute spines, but along the margin, they rather increase in size, especially at the base; and very little difference was perceived between the sexes. Most, if not all other Rays, that have spines on the tail, are furnished with one, three, or five rows, but never with two or four.

The Shagreen Ray described by PENNANT, is undoubtedly a female, or he would have noticed the reclined hooked spines on the wings.

A male that was three feet long, including the tail, which was seventeen inches, and the breadth twenty-four inches, had nine or ten spines above the eye, but in the middle of the brow there was a vacancy: on the snout, which is long, and much resembling that of the Sharp-nosed Ray, R. oxyrinchus, there were several tubercular spines, but scarcely definable, in two rows: behind the head, were seven or eight spines on the dorsal ridge, extending as far back as to be in a line with the branchiæ: on the wings of the male, were the usual four series of hooked spines, very sharp-pointed, each series consisting of two rows: the

the masculine appendages connected with the anal fins, were nearly half as long as the tail. The colour uniformly cinereous-brown, except in one instance, where a few black spots appeared: the whole upper surface is rough like shagreen; the under part white and smooth, except the head, breast and tail.

La Cepede, appears to have described this fish under the title of La Raïe chagrinée; but as I do not find a figure of it in any British work, I beg leave to accompany this with a correct outline, taken from a male, caught on the coast of Devon, where I have examined several of both sexes, but none larger than is mentioned above. Mr Pennant says, it increases to the size of the Skate.

The Shagreen Ray is discriminated by some of the west country fishermen, and is called Dun-Cow.

Raia oxyrinchus.

Having had an opportunity of examining a great many of the Sharp-nosed Ray, and also of the Raia Batis or Skate, two species that are frequently confounded, and rarely distinguished by the fishermen on this coast, and then only supposed to be a sexual difference, I shall offer a few observations on the leading characters. I cannot help noticing, that in the late edition of Pen-

NANT's British Zoology, the identical figure which stood in the former edition, for the skate is transferred to the Sharp-nosed Ray. The same figure is also copied into SHAW's Zoology, for the Skate. This circumstance adds to the difficulty, which the inexperienced ichthyologist has to encounter in distinguishing the fishes of our coasts, because those works are naturally consulted. The snout is the outline character by which these species may be best discriminated; the figure in question, therefore, cannot be supposed to represent both, and in fact, by this sort of accommodation, it is not a correct likeness of either; it is not sufficiently long and slender for the Sharp-nosed Ray, nor enough conic for the Skate.

The Sharp-nosed Ray has a slender snout, the margins of which, in a moderate size fish, run nearly parallel to each other for three or four inches at the extremity. The snout of the skate, on the contrary, is truly conic. The sharp-nose has its skin quite smooth. The skate is entirely rough above, or granulated like a dogfish, and partly so beneath. The under part of the sharp-nose is white without spots. The skate on that part is dusky-grey, covered with minute dusky spots, having a pale speck in their middle. Both species have three rows of spines on the tail when arrived at maturity, but those of the skate differ from most other Rays, by the points of the lateral rows turning forwards. The teeth of both are

sharp, with a broad base, but those of the skate are not near so long, and are more closely connected. The sexes of both species are discriminated by the formidable reclined hooks, as well as by the posterior appendages, both peculiar to the males.

All I have examined of both species, were of a plain brown colour, without spots or lines on the upper parts, and not as represented in the figures before mentioned; but the Sharp-nose is never of so dark a colour as the Skate.

The spines on these fishes are not to be depended on as characters. I have never observed the Skate with a spine at the angle of the eye, as sometimes described. One of four feet in length, had no spines on the tail, but only two or three buds or bony tubercles on the sides. The Sharp-nose appears to grow to a very superior size. I have been assured by fishermen, that they have taken them above five hundred pounds weight by computation, and were obliged to cut them adrift from their lines, for, could they have hoisted them in by the common means of manual exertion of two men, (the complement of each boat), they could not have stowed them. Computing, from the dimensions of one I examined of about a hundred pounds weight, which measured six feet in length independent of the tail, and about five feet and a half in breadth, those of the former weight could not be less than double this dimension. If

this be the Manta of the South Seas, where undoubtedly its size is vastly encreased, well may it be the terror of the pearl divers.

Raia maculata.

Skin smooth, except round the margins of the pectoral fins; the upper part covered with distinct roundish spots of dusky-brown: teeth sharp-pointed: tail armed with usually three rows of spines.

Raia rubus. *Gmel.* p. 1507?—*Bloch*, 3. tab. 83, 84?—*Donovan*, Fishes, ii. tab. 20. fœm.
Rai miraletus. *Donovan*, Fishes, v. tab. 108. fœm.
Fuller Ray. Br. Zool. iii. p. 86. mas.

It must remain doubtful, whether this species was originally described as Rubus, though it is certain, some authors have referred to that fish for it. That it is not the Rubus of Pennant, does not admit of a doubt, and it is as certain that it is the Fuller Ray of that writer. Donovan has figured two varieties of this species; the first he refers to the Rubus, the other to the Linnæan miraletus. Under the difficulty of collecting the synonyms of a species which appears to have been so confounded with others, I have thought proper to select it as a genuine species, and to give it a name derived from the most essential character,

which more or less appears to attend it through all stages of life and season. It is the only truly spotted Ray hitherto discovered as British; and though in shape it approaches R. clavata, its smooth skin and numerous distant round dark spots at once mark its distinction. In fact, it is amongst the few of this tribe that bears such undeniable specific characters.

DONOVAN says, that LINNÆUS was either unacquainted with this fish, or perhaps mistook it, as BLOCH observes, for a variety of the Thornback. How such a mistake could happen to any well-informed naturalist, I cannot conceive, since the cinereous rough skin of the Thornback, waved and mottled with paler lines, and occasionally a few irregular black spots, is so essentially different from the smooth brown skin of this species, invariably spotted like the greater spotted Shark, but the markings more distant. This fish, says Mr DONOVAN, is known on the coasts of Pembrokeshire, by the name of Land Ray. By the same name, it is also known on the western coast, particularly that of Devonshire, where it is equally plentiful with the Thornback. The figure given in the British Fishes, being a female, the pectoral hooks are of course wanting.

As to the Miraletus of LINNÆUS being a distinct species, it has long been doubted, since more than one species have been observed to occasionally possess an ocellated spot on the wing. Mr

DONOVAN remarks, that he has noticed the same spots on the Skate in every stage of growth, and therefore suspects the Miraletus to be only a variety of some other, and mentions the Homerling as its probable origin. Now, as the provincial name of Homerling or Hommelin, has (we are told in the late edition of PENNANT's British Zoology) been applied to the Skate as well as the Rough Ray, neither of which are even similarly spotted, as represented in DONOVAN's figure, I am at a loss to guess what species is meant by the Homerling. In the first volume of the Wernerian Memoirs, p. 553., it will be seen, that in the List of Fishes found in the Frith of Forth by Mr NEILL, the name of Hommelin is applied to Raia Rubus, and which is so clearly defined to be the male Thornback, that we cannot omit transcribing the very significant description conveyed in a few words by that ichthyologist: "This occurs sometimes, especially when trawling-nets are employed, which sweep along the bottom. It resembles the Thornback; but has pointed teeth, while those of the Thornback are obtuse." This so perfectly accords with the opinion I have given, that it does not admit of a doubt that the male Thornback has been described for more species than one, and by many authors for the Rubus. It is rather surprising, that the Miraletus of DONOVAN, should have been likened to the Homerling, when that able ichthyologist had in a former part of his ex-

cellent work, figured a fish so very nearly allied in every appearance, admitting, as he did, that the ocellated spots were accidental. That these two fishes are varieties of the same species, there is no doubt; for I have noticed several varieties, some of which, have had the pectoral spots so faint, as scarcely definable; and it has always appeared in small specimens, and the spots seem to be lost as they encrease to a considerable size.

The principal varieties I have noticed, are, 1*st*, with a white circle round a large dark spot; 2*d*, with a black spot within a white circle, the whole surrounded by five equidistant dark spots, similar to the figure in the British Fishes, except that the white speck in the middle was wanting.

Both sexes of the Maculata have sharp teeth, and most commonly three rows of spines on the tail, the middle row running partly along the back; and after an intermediate space, a few more spines are observable in the same line near the head: on each side of the dorsal row, is a single spine, near the middle of the back: at the corners of each eye, are usually two spines, but very rarely a continuation of spines either over the eye, or along the whole of the back. In smaller specimens, there is frequently only one row of spines along the ridge of the tail; in others, an addition of three or four spines on each side the base, the commencement of the lateral rows. The four series of hooked spines on the

pectoral fins of the male, like others of the class, increase in number and size, in proportion to age. This fish grows to a much larger size than the Thornback, but not so large as the Skate.

Raia microocellata.

Ray with the upper part pale-brown, covered with minute spines that roughen the skin: the under part smooth, white: one row of small hooked spines on the tail, continuing along the dorsal ridge to the head: eyes remarkably small.

Comparing this fish with Clavata, Maculata, and other species of similar size, the comparative smallness of the eyes at once points out a material distinction*. It is in shape like Maculata, but rather more obtuse in front, and except a few scattered pale spots and lines, on the margins of the wings, its colour is plain brown: the teeth are unlike those of Maculata, or either sex of Clavata; they are obtusely cuneiform, with a broad edge, that feels rough to the finger as it is withdrawn from the mouth; in one jaw there are

* The eyes of the specimen described, did not exceed half an inch in diameter from the opposite angles of the eye-lids; whereas the Raia maculata, and most others of similar size, have eyes nearly double that diameter.

53, in the other 56 longitudinal rows, closely connected: in one specimen there was a single large spine, with a broad base before one of the eyes, so that it is possible older fish may be more spinous on that part; above the eyes, the spinulæ were rather larger than those which cover the whole upper surface.

The only two specimens that have come under examination, were females; the largest of which, did not exceed twenty inches in length, of which the tail was nine: the breadth fourteen. As I have not been able to ascertain this fish as a described species, it may be proper to remark, that it appears to be confounded with Raia shagrinea, both being indiscriminately called Dun-cow by the fishermen in the west of England. Without entering into all the distinguishing characters of these two fishes, it will be sufficient to repeat, that the Shagreen Ray has invariably two rows of spines on the tail, but none along the ridge, and both sexes are similar.

In DONOVAN's British Fishes, a new species of Ray is denominated Radiata, from the supposed peculiarity of the base of the smaller spines being radiated; this conformation, however, is not exclusively belonging to that species, for the small spines that roughen the back of Microocellata, and all other species, if examined by a lens, will be found of that structure; this character, therefore,

is only more evident in Raia Radiata, in consequence of the superior size of the spines.

Apodal.

Ziphotheca tetradens.

Wernerian Memoirs, i. p. 82. tab. 2, 3.
Vandellius lusitanicus. *Shaw*, Zool. iv. p. 199?

At the time I submitted an account of this fish to the Wernerian Society, I was not aware that Dr Shaw had described a species in his General Zoology, which so greatly resembles it, as to induce me to suspect it is actually the same, although he has placed it in the Thoracic order. This circumstance caused the obscurity of Vandellius lusitanicus, as no one could have expected to have found an Apodal fish placed in that division. How that naturalist could have fallen into such an error, I cannot conceive, unless he considered the pair of ventral scales as rudiments of those fins, or what is commonly attached to the base of the ventral fins of some fishes, as may be observed in many Spari. It is the more extraordinary, as the description, it seems, was taken from a specimen in the British Museum, which was in high preservation, and yet no mention is made of these ventral scales, nor of ventral fins, although all the other fins are described. If then, it is the same species as the Ziphotheca tetradens,

the Doctor must have concluded, that the ventral fins had been destroyed in preparing the fish, by placing it in the Thoracic order *.

Risso, in his *Ichthyologie de Nice*, has discovered three species belonging to this genus, which he had described under the generic title of Lepidope, and has also improperly (I conceive) placed them in the Thoracic order, although he describes them as having no ventral fins. One of these species appears to possess many of the characters of Shaw's fish; and Risso remarks, that he suspects Shaw's fish to be the same as his Lepidopus Peronii, tab. v. fig. 18., although he says Shaw is silent with respect to the pair of ventral scales; and that he also describes the three single fins (dorsal, anal, and caudal) to be united.

In this particular, Risso has certainly misconstrued the meaning of Dr Shaw's words, who, though not quite correct, or sufficiently defined in his description, (supposing V. lusitanicus to be the

* I am aware it has been contended, that these abdominal scales are lamellated ventral fins. If so, we have yet to learn the definition of a Fin in the modern revolution of science. Those who contend for the continuance of Vandellius of Shaw, or for the Lepdope of Risso being continued in the Thoracic order, must also constitute a new order for many fishes that have such lamellated appendages, independent of two ventral fins. But I cannot admit of a simple corneous scale, destitute of motion, being a ventral fin.

same as Z. tetradens) says, "The dorsal fin is continued from the hind part of the head throughout the length of the back, as far as the tail, which is small, and very much forked, with sharp tips. The anal fin is much shallower than the dorsal, and commences at the distance of but a few inches from the tail, to the base of which it is continued." This description does not imply an actual union of the three fins, but that the dorsal and anal fins extend as far as, or to the base of the caudal fin. I do not recollect any example of a forked termination of the fin of a tail, where there is no division between the three fins.

Risso also refers to Trichiurus caudatus, given by Euphrasen in the new *Transactions of Stockholm*, vol. ix. p. 48., and to Walbaum's *Ichthyologie d'Artédi*, iii. p. 694., who he seems to have followed in his genus Lepidope.

Dr Shaw appears to have derived some information concerning his fish from Dr Vandelli of Coimbra, who had called it Trichiurus ensiformis, the name by which it was known in the British Museum. In the Vandellian fish described by Shaw, and that given in the Wernerian Memoirs, the larger teeth are only four, all situated in the upper jaw; and the only difference in description, appears to have arisen from the circumstance of the two posterior ones not having been observed to be placed on the palate, just within the arrangement of the smaller teeth.

Risso's fish had seven teeth larger than the rest, two in front of the under jaw, two in front of the upper, and three longer, crooked and moveable, adhering to the palate. These moveable teeth, did not exist in the Ziphotheca tetradens, nor does it appear that Risso's fish had the two posterior fixed semisagittate teeth, belonging to this species. If we attend to the figure and description of Risso's fish, we shall find other circumstances that appear irreconcilable in the same species. His fish has rounded pectoral fins; ours, acutely pointed: his is described to have 200 rays in the dorsal fin; ours only 105,—a disproportion of which there is no instance in the same species*: the anal fin of his figure is longer by two-thirds, containing 40 rays, though the description says 22; ours has 17 rays†: the operculum of the gills consists of two plates in his fish; in ours only one‡. Risso's fish is described to have been covered with silver, reflecting with gold, and shaded with pink and azure; ours, as well as Shaw's, were of a rich silver. These are differences which cannot be reconciled in the same species: especially the vast disproportion of the rays in the dorsal fin, seems to forbid these fishes being brought together, for as it extends

* Shaw's fish had 105.

† 20 in Shaw's fish.

‡ Shaw says one plate.

the whole length in both fishes, the organization must be different, where double the number is contained in the same length.

At the time I sent the account of Ziphotheca tetradens to the Wernerian Society, *Ichthyologie de Nice* was not published, from which it appears Risso had only seen one specimen of his Lepidopus Peronii.

Dr Shaw speaks of his fish having been taken in the Mediterranean and Atlantic Seas, though rarely, and that it had occurred near Lisbon.

Leptocephalus Morrisii.

Plate xxii. fig. 1.

It appears extraordinary, that, after the description and figure given of this curious fish by Mr Pennant, who personally examined it, and from which a drawing was taken, there should still exist a degree of scepticism amongst the scientific, concerning the actual existence of such an animal. The editor of the late edition of the British Zoology, wishing to remove all doubts concerning it, and justly bestow all the deserved credit on so able a naturalist, to whom the world, and in particular his native country, is under so much obligation, has collected together several other instances of this fish having been taken on the coast of Wales. Here we find a letter from the Rever-

end HUGH DAVIES, declaring, "that it has been his lot to see no less than four specimens, three of which were taken in the amusement of prawning, below Beaumaris Green."

Another instance is related of a similar fish being captured by Mr LEWIS MORRIS, brother to the gentleman who sent the original specimen to Mr PENNANT. Of this fish, Mr MORRIS took a short description, and a rude drawing, but sufficient to identify the species. These are powerful auxiliaries in proof of the existence of such a fish, if any thing was required, after we have Mr PENNANT's assertion that he had the original, and sent an account of it to GRONOVIUS, who described and figured it in his *Zoophylaceum*. It is, however, extraordinary, that neither Mr PENNANT nor Mr DAVIES, should have preserved an animal so rare, and of so singular appearance, since it was attended with no other trouble than putting it into a small phial of spirits. It is a grateful task in bearing record of the verity of the writings of a scientific friend, by existing facts, which I am enabled to do, by being in possession of two perfect specimens of Leptocephalus Morrisii. These were presented to me by my valuable scientific friend, Mr ANSTICE of Bridgewater, having been taken near that place in the River Pervet, one in the year 1810, the other the following year. Both were taken by a hand-net, near the surface of the water. As these speci-

mens are in high preservation in spirits, they afford an opportunity of critically examining them, and enable me to correct some mistakes into which Mr PENNANT had inadvertently fallen, probably from the necessity of describing from a bad specimen. The most material defects in the original description, are the want of pectoral and caudal fins, as they form leading generic characters, and bring it nearer to the Muræna. The following characters would be more appropriate:

Generic.

Head small: body laterally compressed, and extremely thin: fins, dorsal, anal, and caudal, united: branchial aperture small, transverse.

Leptocephalus, *Gronov.* Zooph. p. 13. f. 3. — *Cepede,* 11. 143.—*Gmel.* p. 1150.—*Shaw,* Zool. iv. p. 84. t. 10.—Brit. Zool. new edit. iii. p. 212. t. 28.

The largest specimen is about six inches in length, and half an inch broad; the thickness does not exceed the sixteenth part of an inch: the head is small, but is nearly in a straight line with the back: the jaws nearly equal in length: the teeth numerous, and all incline forwards: eyes large; irides silvery. The dorsal fin does not extend the whole length of the back, as originally described, but commences at nearly one-third of the length of the fish from the head;

the anal fin commences immediately behind the vent, which is situated a trifle nearer the head than the tail; these fins unite at the posterior end, and form a caudal fin, as in the Eel and the Ophidium imberbe: the pectoral fins are extremely small, not exceeding a line in length, so that it was scarcely possible that they should have been noticed in Mr PENNANT's specimen, where the posterior end also had contracted into a point, destitute of fin, probably from drying. That none of these characters, so different from what was originally described by Mr PENNANT, should have been noticed by Mr DAVIES, who says he has seen four specimens, is only to be accounted for, by supposing, they had been suffered to dry before examination, by which the delicate texture of the fins was irrecoverably lost, as I found to be partially the consequence of one of my specimens having been put into a letter to preserve it till the captor reached home, when it was immersed in spirits. Yet, with this care, the caudal fin was obliterated, and the dorsal and anal incomplete. I cannot discover any operculum to the gills, which are extremely obscure; nor is there any appearance of branchiostegous rays; it is only in the living fish these parts can be expected to be sufficiently definable*.

* Mr PENNANT was certainly deceived with respect to the aperture of the gills, which he describes to be large.

In the original description, no mention is made of the minute black spots on the margin of the back and belly; but it seems in Mr LEWIS MORRIS'S memorandum, in the possession of Sir JOSEPH BANKS, mention is made of these markings: the lateral line is nearly in the middle, and straight: the oblique strokes that meet at the lateral line, described by Mr PENNANT, are formed by the vertebral bones: the colour, when alive, is very pale, destitute of any markings, except the minute spots before mentioned, and the whole fish is semipellucid.

The drawing which accompanies this paper, is of the natural size of the largest specimen. The pectoral fins are extremely small, not discernible without a lens; in order to shew them, therefore, it was necessary to exceed the natural size and colour.

JUGULAR.

Callionymus Dracunculus.

After what Mr NEILL has detailed in the first volume of the Wernerian Transactions, it may appear useless to throw any doubts upon the opinion, that the Sordid and Gemmeous Dragonets are only different sexes of the same species; but the singular fact hereafter related, though it revives suspicion, and may induce scientific persons to pursue their researches, does not by any means

prove to the contrary. It certainly was reasonable to conclude, after several dozen of each had been opened by Mr NEILL, and found to be constant in sexual distinction, that these two fishes were of the same species *. Mr NEILL, too, assures us in the same work, that he had these fishes brought to him in nearly equal numbers. This is the more remarkable, since on the south coast of England, especially Devonshire, the Dracunculus is very common, and the Lyra extremely rare. Previously to the discovery of this circumstance, I confess, the great similarity of the two fishes, had induced me to suspect only a sexual distinction.

At the fishery I am in the habit of attending on the coast of Devon, I have scarcely ever seen the tack-net or ground-net used, that several of the Dracunculus were not entangled: I might venture to assert, that more than a thousand are taken by the fishermen of Torcross alone, annually, and yet only one instance of the other species having been taken, has ever come to my knowledge, and which was sent to me by a fisherman of that

* It is proper here to remark, that Mr NEILL, like a true naturalist, always in search of fact, has candidly admitted, that his conclusions were drawn from having always found the Gemmeous Dragonet a *milter*; but that he never could detect either row or milt in the Sordid.

place, as an extraordinary fish, unknown amongst the fraternity.

With a knowledge of such facts, I cannot but be staggered in my opinion, and hope that the Secretary to the Wernerian Society may be induced to prosecute his inquiries by dissection, at different seasons of the year. The specimens of Dracunculus are not very large on this coast, seldom exceeding eight inches, more frequently not above six, and sometimes not so much as two inches; a circumstance, that proves without doubt, that it breeds contiguous to this coast.

I have opened many in the months of July and August, but without having been able to ascertain the sex; a circumstance not unusual in fishes, except at the critical time of the year, when the ova are enlarged, or the milt becomes tumid. Even some viviparous fishes have long eluded the search for sexual distinction.

The Dracunculus is held in utter detestation by the fishermen on this coast, from the supposed venom communicated to the wound inflicted by the tridentate spine on each side the head. From this circumstance, it has acquired the appellation of Stingfish, a name applied to the common Weaver, Trachinus Draco, in other places. When the Dracunculus is caught, no mercy is shewn to it, being indignantly buried in the shingle by a stamp of the foot.

To the great astonishment of the natives, I collected some of this species for culinary purposes. In taste, and in the dryness of the fish, they much resembled the Common Gurnards.

Blennius ocellaris.

Blennius ocellaris. Lin. Syst. p. 441.—*Gmelin*, p. 1156. —*Bloch*, t. 167. p. 1.—*Shaw*, Zool. iv. p. 165. t. 24.

Plate xxii. fig. 2. natural size.

The Ocellated Blenny appears to be well known as a Mediterranean fish, but no one, I believe, suspected it to inhabit our shores. I have the pleasure, however, of adding it to the British catalogue.

In the summer of the year 1814, three of this species were taken by the dredge on the oyster-bed at Torcross, on the south coast of Devon, all of which came under my inspection, and I had the satisfaction of examining one in a living state; but it did not survive the day, though the vessel in which it was placed was frequently replenished with sea-water, so different is its constitution from that of the Smooth Blenny, B. pholis, which I have kept alive for two days in a moist place, without being covered with water.

It is possible that the Ocellaris may occasionally have been confounded with the Gattorugine,

since that species has by some been described with a black spot on the dorsal fin; and I suspect the Ocellaris is not always furnished with that mark, as one instance has occurred where it was scarcely defined.

As there are some peculiarities in this fish, which do not appear to have been noticed, I trust the following description, accompanied with a figure, will be the means of its being clearly identified, should it ever occur without the spot on the dorsal fin. Independent, therefore of the mark from which the name is derived, and which is not always ocellated, I submit the following specific characters:

A crust over each eye, digitated on one side: a long crooked tooth far back on each side the under jaw *: one dorsal fin, the first ray of which is longest: ventral fin with three united rays: a minute membranaceous flap on each side the back near the head; another at the upper angle of each gill.

The shape of this species is somewhat similar to that of the Gattorugine, but the forehead is more sloping: the eyes are placed high, but not above the level of the crown, as in the Gattorugine, nor has it any transverse sulcus behind the head,

* SHAW says B. cornutus has two long teeth in the under jaw.

as in that fish *: the teeth are numerous, closely connected, and even; the two fangs are observable only when the mouth is extended: the irides are silvery, with a golden tinge round the pupil, which is blue-black: the tentacula, or cirrhi, over the eyes, are pinnated only on the posterior edge; the pinnæ are usually five, which are flat, the two lowest larger than the others, and broader at the end: the dorsal fin is very broad, indented about the middle, consisting of twenty-five rays, the first of which is sometimes one-third longer than the others; the eleventh ray is very short, from which the posterior half of the fin rises abruptly, the twelfth ray being double the length of the preceding. This circumstance has probably occasioned the error into which CEPEDE has fallen in describing two dorsal fins †.

The dorsal fin is uniformly connected throughout, like that of the Gattorugine, but materially differs from it in the essential character of the first ray being longest. It should, however, be remarked, that in some instances the first ray is

* Blennius sulco inter oculos, macula magna in pinna dorsali. ART. gen. 26. Syn. 44. referred to by GMELIN for the Ocellaris, would appear to be an ocellated variety of Gattorugine.

† RISSO has fallen into the same error, as well as LINNÆUS. ARTEDI and BLOCH are correct in giving it but one dorsal fin.

but a trifle longer, though in others it greatly exceeds the rest; perhaps a sexual distinction. The pectoral fin has twelve rays: anal eighteen: caudal twelve. The ventral fin has certainly three united rays, notwithstanding it has been usually described with only two; the outer is rather shorter than the inner, and the middle one the longest. In this particular, it also differs from the Gattorugine, whose ventral fin consists only of two rays: the colour of all that have come under examination, was pale rufous-brown, mixed with bluish-grey, and slightly tinged with green in some parts; the sides of the head, throat, and branchiostegous rays, prettily spotted with rufous brown: the dorsal fin is also a little spotted and barred with olive-brown and white; and between the sixth and eighth ray, is a roundish purple-black spot, sometimes surrounded with white. Hitherto, I have observed, that those with the most perfect ocellated spot, had the first dorsal ray very long. Length nearly four inches; depth at the gills, about an inch.

It must be recollected, that B. cornutus and B. tentacularis, have both an ocellated spot in the dorsal fin; these may be varieties of the same species, but appear to be distinct from B. ocellaris, whose dorsal and anal fins have not near so many rays in them as the others.

Blennius Gattorugine.

It appears extraordinary, that this fish should be by some naturalists described to have the anterior rays of the dorsal fin spinous. GMELIN says sixteen rays; but as other authors are silent on the subject, I presume it is a mistake. None of the genus I have examined, possess any spiny rays in the dorsal fin, but generally terminate with a shining membrane.

There is a strong character which belongs to several Blennii, that does not appear to have been generally attended to, and which seems well calculated to form a generic character, and might with propriety be used to separate them from the rest. This is a loose membrane or foliation of the skin, which passes under the throat from the opercula of the gills, enveloping the branchiostegous rays. This is equally evident in the Ocellaris, Cristatus, and Pholis, as well as in the Gattorugine.

This, like the three species just mentioned, has a flexure in the dorsal fin: the first and thirteenth ray are by far the shortest; the fourteenth exceeds the preceding by nearly one-half: the following increase in length, except the few posterior ones; the superior breadth of this part of the fin, and the indenture in the middle, gives an appearance

of two dorsal fins. The figure in PENNANT'S British Zoology, is a tolerable representation; but the posterior part of the dorsal fin is not sufficiently rounded. This author mentions the sulcus on the back of the head, but he is certainly mistaken in calling the fourteen anterior rays of the dorsal fin spiny. In DONOVAN'S British Fishes, the posterior half of the dorsal fin is not represented sufficiently broad, but the figure has properly only one, although, by the author's description, we are induced to conclude, the fish has actually two dorsal fins, as we are told "the *first* dorsal fin contains thirty-two rays."

Having carefully examined several specimens, we are at a loss to discover what can be intended by the double lateral line described in the British Fishes. I take the liberty of making mention of this circumstance, as the lateral line in my fish is single, forming a considerable arch above the sweep of the pectoral fin, but there is no other line formed by the bones in a rectilineal direction from the head to that flexure. Both Dr SHAW, in his Zoology, and Mr DONOVAN, have described the Gattorugine to possess four palmated membranes on the head; the first pair over the eyes, the other over the back of the head. Other authors mention only two, and those situated over the eyes, which is conformable to the specimens now before me.

These circumstances are mentioned, because many of these smaller fishes are in great obscurity; and possibly allied species, not yet clearly identified, may be confounded.

A specimen lately taken in a crab-pot, on the south coast of Devon, is seven inches long, and one inch and a half deep behind the head. The colour plain rufous brown, without any markings, paler on the belly, as far as the vent; throat and fins red-orange, except the base of the dorsal and pectoral fins: the cirrhi over the eyes, orange colour, broad and fimbriated each side. The irides were orange-red, and when the fish was examined in profile, the eye stood higher than the crown, and the sulcus behind the eyes gave a gibbous appearance to the commencement of the back.

Dorsal fin 33 rays; pectoral 14; ventral 2; anal 20; caudal 12.

Gadus argenteolus.

There is a small species of Gadus, which is occasionally found on the western coast, that is nearly allied to the Three-bearded Cod, Gadus mustella, in most particulars, but the shape of the head and the colour are essentially different. It has very much the appearance of the fry of some larger species, and might have been suspected to be the young of the Ling, G. molva, had it not

been for a little difference in the first dorsal fin, and the two cirrhi which this has before the nostrils. If a fourth cirrhus could have been discovered, suspicions would have arisen, whether it might not have been the Cimbrius of GMELIN. Its essential characters may stand thus:

With two dorsal fins, the anterior very obscure, except the first ray, which is much the longest: cirrhi three, two before the nostrils, and one on the skin: upper jaw longest: back bluish-green: sides and belly silvery.

The head is obtuse: eyes lateral; irides silvery: all the fins are of a pale colour, and the whole fish is of a silvery resplendence, except the back, which is blue, changeable to dark-green: the pectoral fin is rounded with sixteen or eighteen rays: ventral six or seven, the middle ray considerably the longest, and placed much before the pectoral: first dorsal fin commences above the gills, and the rays are very minute and obscure, the first excepted, but more than thirty have been counted: the second dorsal commences close to the other, in a line with the end of the pectoral, and terminates close to the caudal; the rays are innumerable: the anal fin begins immediately behind the vent, and terminates even with the dorsal: the caudal fin is nearly even at the end.

Length about two inches.

I first noticed many of these fishes thrown upon the shore in the south of Devonshire, in the

summer of 1808, and have taken two or three since. The fishermen called it White-bait, but I afterwards found they had mistaken it for the fry of Herring and Pilchard, which indiscriminately go by that name, and are together sold in some places under the name of Herring Sprat*.

The Three-bearded Cod, G. mustella, is a very common species on the western coast, and which I have taken of all sizes, from the most minute, to its full growth of sixteen or seventeen inches, and never observed it to vary in colour, except, as it grows large, it becomes more rufous and throws out spots, which is never observed till it exceeds six or seven inches, but is invariably rufous brown in its infant state.

Thoracic.

Sparus lineatus.—Black Bream.

Plate xxiii. reduced.

The fish belonging to the genus Sparus, which is here described, is somewhat allied to that given

* These are undoubtedly the same as the Sprat of the eastern and northern parts of the kingdom. The only difference, is, that the Herring fry only are caught on these coasts; whereas both are taken in the west, at all times of the year, both of the first and second year's growth, as well as full-grown fishes.

by Dr Shaw, Zool. iv. tab. 62., called Bufonites; but the great dissimilarity of the bony plates beset with teeth, found in the fauces of these fishes, forbid their being brought together. Commerson, who it seems presented Buffon with a drawing of the Bufonites, observed also another species in the Indian Sea much allied to it, and which has been figured by Cepede; but I should scarcely dare venture to refer to either of these lineated Spari, found to inhabit an oriental climate, even if other circumstances better corresponded. At present, I have searched in vain for synonyms to the lineatus; at any rate, it is a species that has undoubtedly escaped the notice of all British naturalists who have written on native ichthyology, although it is by no means an uncommon fish on the south coast of Devon.

Back much arched and carinated: the lower angle of the caudal fin shorter than the upper.

The front of the head from the mouth, round the eyes, and for half an inch or more behind them, across the crown, is destitute of scales, of a yellowish-brown colour; under the eye a scaly space, below which is another smooth part, taking in the margin of the upper plate, and the edge of the posterior plate of the operculum of the gills; the smooth parts the same colour as the last, but the edge of the upper plate is blue; from the smooth part on the top of the head, an arched line runs downwards, which is also smooth and

partly *encircles* a scaly space: in each jaw, one row of larger teeth, those of the upper rather superior in size; within these, the mouth is roughened with minute denticles: the irides are partly dusky and silvery. The colour is usually dusky-blue, with paler longitudinal lines. Sometimes they are of so very dark a colour, approaching to black, that the lineations are obscure, which has induced the fishermen to call them Parsons.

By comparing this species with the Red Bream, Sparus Pagrus, of similar size, the following distinction is obvious: The back is more arched behind the head, and less sloping from the nostrils to the mouth in front: the tail is rather less forked, and the angles unequal, which is not observable in the Red Bream: the eye of the Black Bream is one-fourth less; this has no dusky spot behind the head: the Red Bream has a spot above the base of the pectoral fin on the lateral line: all the fins of this are dusky, with a blue tinge; the fins of the other are more or less red: the mouth is more protruded, and not red within as in Pagrus: this is deeper in measurement, by nearly one-fifth; is more compressed, and carinated on the back, than the other: the fins of both fishes have nearly the same number of rays, but they are much broader in this than in the red species: the teeth in the fauces are small and slender, similar to what are found in the other, and not in the least like the Bufonites. It does not grow to

the size of the Red Bream, but is frequently fifteen inches in length, and five inches in depth behind the head.

The Black Bream is considered of less value than the Red; both are taken near shore by the hook, and sometimes by nets, in considerable abundance, but the Red is much more plentiful.

I shall take the liberty of remarking in this place, that in the late edition of PENNANT'S British Zoology, a little confusion appears with respect to the Rayan and Toothed Gilthead, which might occasionally perplex the inexperienced ichthyologist. It will be seen in the former edition of that work, the Rayan Sparus is figured and called the Toothed Gilthead. In the last edition, the Toothed species, Sparus dentex, of the former edition, is referred to for Sparus Raii; but the same figure stands unfortunately with the original name of Toothed Gilthead engraved upon the plate.

Trigla.

Four species of this genus, out of the five or six described as British, are usually confounded by the fishermen under the name of Tub, and it must be confessed, that persons of better infor-

mation are extremely puzzled to define them. This confusion is encreased by another species being blended with them, that hitherto does not appear to have been described, though by no means rare. It has probably been mistaken for the Sapphirine Gurnard, Trigla hirundo, from the great length and breadth of the pectoral fins, but is at once discriminated from any other species, by the smoothness of its skin; from which circumstance, it may with great propriety be called Smooth Gurnard, or

Trigla lævis.

Head and body as far as the vent, large: body entirely smooth: pectoral fins very long and broad, reaching beyond the vent: spine on the operculum of the gills, very short.

Front slightly bifid, a little roughened with denticles: on the side of the head, three spines as usual; that on the operculum of the gills, remarkably short and blunt, scarcely projecting beyond the margin: lateral line straight and elevated, but quite as smooth to the touch as the rest of the body: on the upper anterior angle of the eye-brow, are two obtuse denticles: the back slightly serrated on each side the dorsal fins: teeth minute, numerous: first dorsal fin has the

second ray a trifle the longest; the rays spiny and smooth: the rays of the second dorsal fin, are nearly of equal length, except the first, which is shortest: pectoral fins very large. The colour above is pale yellow-brown, tinged with red, and faintly mottled: the first dorsal fin reddish; the second is almost colourless: caudal fin red: the pectoral fin on the outside, has a dingy-blue cast, dashed with red on the webs, the rays white, with a blush of red; on the inside dingy-blue, clouded, the margin bright-blue, the two lower rays red: ventral fins nearly white, tinged red at the end: anal fin white, tinged red: the under part of the fish is white, which colour commences some distance below the lateral line.

This fish grows to a large size, some more than two feet in length, and very tumid round the belly. Were it not for the smoothness of the skin, it might be mistaken for the Sapphirine Gurnard by the pectoral fins being equally large, but they are never spotted with bright blue, as in that species. The inside of the mouth is white; under the gills the same, yellowish towards the upper angle: the caudal fin is slightly forked, but almost even when spread to the utmost, and the angles of equal length. First dorsal fin 9 rays; second dorsal 16 rays; pectoral 9; ventral 6; anal 15.

This species is taken by the shore-nets, as well as by hook, the finest when fishing for Whiting, by a bait of launce. It is sometimes called Yellock, at Torcross, by some of the fishermen, but generally confounded with the Sapphirine, the Red, and the Streaked Gurnards, under the denomination of Tub. For the table, none of the Gurnards are held in much estimation in this part of the country, although the celebrated epicure, Mr QUIN, set some value upon a west country Piper. The whole tribe requires good sauce, being naturally dry; but the Smooth Gurnard is not inferior to any.

The air-bladder of this fish, is large and trilobated; whether this is the same in all the other species, I am at present unable to determine.

Trigla cuculus.

There appears to be one striking character in the Red Gurnard, which is not generally described. In SHAW'S Zoology it is retained; and the figure in the British Zoology represents it, although it is not mentioned in the description. This is a remarkable black spot at the top of the first dorsal fin, which, as far as I have observed, by examining many specimens, seems to be con-

stant. The name of Red Gurnard, given to this species, is misapplied, because it partakes less of that colour than many others; and consequently, the red variety of the Streaked Gurnard is generally considered as this fish. The species in question with the dorsal spot, is in colour more like the Grey Gurnard, T. Gurnardus, but with a rosy tinge; it is a mixture of grey, yellow, and roseate, but possibly season and climate may incline it more to red. BLOCH has made the dorsal spot an essential character; but the number of rays in the dorsal and anal fins is so very different from what I have noticed, that it is difficult to determine these to be the same *. It will be seen, that our fish has three spines less in the dorsal, and six rays more in the anal than BLOCH'S fish. PENNANT has given the same number as ours in the ventral, and two more in the dorsal. That the rays of the fins are by no means constant characters, is well known; but the difference of one-third of the number is greater than I ever recollect to have noticed.

It must be admitted, that the history of fishes is yet very imperfect. Much is required to be done, in order to define the species of some intri-

* Trigla corpore rubro, macula nigra in pinna dorsali prima. Dorsal 10, 18; pectoral 10; ventral 6; anal 12; caudal 15.

cate genera, so that we may with more certainty identify the individuals. Every information, therefore, which proceeds from actual examination, must conduce to enlighten the subject. With this view, I shall shortly describe what appears to me to be a common variety of Trigla cuculus.

The forehead is more sloping than that of the Grey Gurnard; the nose armed with three spines on each side: the spine on the operculum of the gills, and that behind it, are long and rough: lateral line, and ridge of the back, each side serrated: a large black spot on the first dorsal fin at the margin, extending between the third and fifth ray.

The whole body is rough: the spine on the gill-covers, extends nearly as far as the spine behind it: the lateral line, and ridges on the back, more strongly serrated, than on the Grey Gurnard: the first dorsal fin has seven spiny rays; the second ray scarcely longer than the third when reclined, the two first rough, the webs tinged rosy; second dorsal fin nineteen soft rays, rosy towards the margin: pectoral fins not very large, with ten rays, of a bluish tinge, scarcely reaching to the vent*: ventral fins six rays,

* Pennant says the pectoral fins are edged with purple.

white: anal fin eighteen rays, white: caudal fin rosy, and slightly forked when spread.

Many of these are taken in the summer months on the coast of Devon, by the shore-nets; their size inferior to the other Gurnards, rarely exceeding a foot in length, and seldom above nine or ten inches.

Trigla lineata.

There appear to be two distinct species of lineated Gurnards; that originally described by Mr Jago as a Cornish fish, introduced by Mr Pennant into the British Zoology, and one figured by Mr Donovan in his British Fishes. The former is one of the most common fishes on the south coast of Devon, where it is frequently called Red Gurnard, as well as Tubfish. It is extremely variable in colour, from a bright-red to a dark-brown, sometimes almost black upon the back. I have examined several hundreds of this species, which I consider as the same originally discovered in Cornwall.

The fish described by Mr Donovan for the lineated Gurnard, has the remarkable character of the lines crossing the whole fish, being elevated and divaricating on the belly. In our fish,

the transverse lines are confined to the region of the lateral line, which they intersect nearly at right angles, do not exceed three quarters of an inch in length, and are cut nearly in half by the lateral line, so that their lower extremities do not reach above half way down the sides of the fish, and are destitute of divarications. It must also be observed, that these lineations are scarcely obvious in a fish recently taken, but become more definable as the skin dries. The lateral line is very slender, and not more rough to the touch than the rest of the fish, when the finger is rubbed in reverse; the scales being serrated, occasions the roughness. Perhaps the following leading characters may be advantageously applied to this fish:

Skin rough, with joint transverse striæ across the lateral line: nose slightly bifid and crenated: above the anterior angle of the eye, two short spines: pectoral fin not extending beyond the anus: first dorsal fin with the second spinous ray very superior in size to the adjoining, and exceeding them in length nearly half an inch when erect, and when reclined, extending as far as the base of the third ray of the second dorsal fin.

This fish is frequently of a beautiful deep rosy red on the sides; the back clouded with brown or

cinereous, tinged with red, and occasionally deep-brown, bordering on black: the sides of the head under the eye, usually red: the under parts from the chin to the caudal fin, white: the spine on the margin of the operculum of the gills, is short: the dorsal fins reddish, the two anterior spines excepted: pectoral fins underneath, orange-red, clouded and speckled with dusky and brown, the outside paler: the three digits brown, tipped with pale red: ventral fins white on the outside, pale red within: the anterior half of the anal fin is white, the rest bright orange-red: the caudal fin is mostly red, with a little mixture of dusky, and is a trifle forked when spread: the ridge of the back on each side the dorsal fins, strongly serrated.

The number of rays in the fins, are, dorsal 9—18; pectoral 10; ventral 6; anal 18.

This species is taken in great abundance on the western coasts, where it is generally supposed to be the Red Gurnard, though usually confounded with others under the provincial name of Tub. It rarely exceeds fifteen or sixteen inches in length. Is frequently taken by bait, fishing for Whiting, as well as by the shore-nets; and as it is subject to so much variation in the colour, those of the darkest kind, with very little red on the head and sides, have been brought to me for a distinct species; for many in the highest per-

fection of colour, appear to be more rosy than any other species of Gurnard. In all these variations, the second spine in the dorsal fin, (which is much longer than any other, and nearly double in diameter), appears to be the best mark of discrimination.

XXVIII. *Observations upon the Alveus or General Bed of the German Ocean and British Channel.*

By Robert Stevenson, Esq., Civil Engineer.

(*Read 2d March* 1816.)

In the course of making professional inquiries regarding the impression which the tidal waters of the Frith of Forth are making upon some of the most valuable properties situated upon its banks, I have been imperceptibly led to compare these with other observations that have occurred to me in a pretty extensive survey of the coast of Great Britain and Ireland. On this subject, involving not only an important question regarding the *Economical Interest* of the country at large, but also some points connected with the Natural History of the globe, I shall lay before the Society what occurs to me, in hopes that it may at least

have the effect of turning the attention of more skilful observers to its further elucidation.

I am therefore, in this introductory paper, to endeavour to prove, that the tidal waters of the British Channel and German Ocean, are acting upon the coast of this kingdom, and wasting its shores, by a constant and almost invariable progress. This is, perhaps, more or less obvious to every one; but I shall here bring it more distinctly under the notice of the Society, in so far as my intercourse with the different parts of the coast has afforded an opportunity of observing; and shall add such collateral remarks as may occur in the course of this inquiry. Having in this manner established the point with regard to the wasting of the shores or margin of the land next the sea, I shall, in a future communication, inquire into the cause of this wasting, and endeavour to account for it. Without supposing it to proceed from an increase of the waters of the ocean, or to depend upon any adventitious circumstances connected with the natural state of the tides, I propose to shew that it proceeds from a change upon the level or depth of the *alveus*, or general bed, of the German Ocean and British Channel.

It would open a field of inquiry too widely extended, to enter upon the evidence of the water of the ocean having in former ages occupied a

much higher level than it now does. As already said, I am only at present to trace the encroaching or wasting effects of the sea upon the land. In doing this, I shall begin with the shores of the Frith of Forth, and then proceed northward along the eastern coast to the Moray Frith, Caithness, and the Orkney and Shetland Islands; next slightly notice the Lewis, and the western parts of Scotland; and then turn my attention to the eastern shores of England, and to the British and St George's Channels. From the extent of coast just alluded to, it will be obvious, that I can take but a very slight and partial view of the effects of the sea upon the shores at particular bays and creeks, which might deserve further illustration.

Frith of Forth.

The wasting operations of the sea are not confined to the more exposed parts of the coast, but are observable in our most sheltered seas, upon both sides of the Frith of Forth westward, or above Queensferry, where the shores are defended on all sides from the violent attacks of the sea in stormy weather: Even in this narrow part of the Frith, we find that the land is gradually washed away by the tides, as, for example, at Lord DUNDAS's estate at Grangemouth, and all the southern shore by the estate of Kinniel and the Earl of HOPETOUN's lands, to Queensferry, at which place the track of the public road is now literally within sea-mark, although at no great

Stirling and Clackmanan.

distance of time it was defended from the sea by a tract of land. The same remarks are strictly applicable to the shores on the northern side at Culross, and along the estates of Sir ROBERT PRESTON and Lord ELGIN, and all the way to North Queensferry. From an inspection of the charts of the coast, it will appear, that these effects are not likely to have been produced from any particular exposure, as this part of the Frith is completely *land-locked*, and is otherwise well sheltered from storms. These appearances would therefore seem to imply a change upon the level of the ocean, occasioning an *overfilling* of the various *inlets* of the sea.

Below Queensferry, or to the eastward of it, these effects are perhaps still more remarkable. On the southern side of the Frith at Barnbougle Castle, the seat of the Earl of ROSEBERY, in former times there was a lawn of considerable extent on the eastern front, and on both sides of the castle: This lawn is now completetly washed away by the sea, and it has long since been found necessary to erect a bulwark for the safety of the castle, which is rapidly approaching to an insulated state, so that the Noble Proprietor has in some measure been under the necessity of building a new mansion-house upon a more elevated situation. Tracing the same shore, along the rocky boundary of Granton and Royston, to Wardy and Newhaven, we are no less struck with

Linlithgow.

Shire of Edinburgh.

the powerful effects of this element. Between Newhaven and Leith, where the subsoil consists of strong clay overlaid by a deep cover of alluvial matters, it is in the recollection of some old fishermen still living, that an extensive piece of Link ground or Downs existed in front of the lands of Anchorfield and along these shores, on which they used formerly to dry their nets, and which is now entirely washed away. From the fishing village of Newhaven to Leith, the direct road was along shore on the northern side of Leith Fort; but the road being now carried wholly away, and the sea having penetrated considerably into a field on the eastern side of the houses of Anchorfield, the carriage road takes a circuitous route by another way; and there is reason for believing, that at a former period the land here had extended, probably as far to the northward as the Martello Tower or Black Rocks.

Of the wasting effects of the sea on the shores of the shire of Edinburgh, some striking proofs are adduced, and others may be drawn from MAITLAND's *History of Edinburgh*, in which he speaks of a tract of land on both sides of the Port of Leith, which has now wholly disappeared. In particular, at Newhaven, a village which appears to have been established in the beginning of the 15th century, by King JAMES the IV., who there caused a harbour to be constructed for the reception of vessels, and a dock-yard or arsenal,

with rope-works for building and fitting out ships, the remains of which, as also of a glass and salt work, were visible in 1750, when MAITLAND wrote. He mentions, also, that the great ravages of the sea upon the coast, between Leith and Musselburgh, have occasioned the "public road to be divers times removed further into the country, and the land being now violently assaulted by the sea on the eastern and northern sides, all must give way to its rage, and the Links of South Leith probably in less than half a century will be swallowed up." It is also well known, that this process has in nowise abated, as the road alluded to has of late years been again and again removed from the sea, and is now in some places defended by bulwarks of stone, to preserve the present line. Even the New Baths erected but a few years since at a considerable distance from the high-water mark, have now barely the breadth of the high-way between them and the sea, which has overthrown the bulwark or fence in front of these buildings, and is now acting upon the road itself.

Proceeding along the *southern* shores of the Frith of Forth from Leith to Berwick-upon-Tweed, many instances are afforded of the waste of the land by the sea. The shores near Musselburgh, at Morison's Haven, and Prestonpans, have suffered greatly from the sea. An instance of this is remarked of the link-ground or downs of the former place, where JAMES, Duke of Albany and

Haddington and Berwick:

York, when he resided at Pinkie House in that neighbourhood, used to take the amusement of golf; but now these extensive grounds are almost entirely swept away. The Earl of Wemyss's lands of Gosford, Gullenness, and all the shores extending from Dirleton Common to North Berwick, the Earl of Haddington's lands of Tyningham, Dunbar, Broxmouth, Dunglass, to St Abb's Head, Eyemouth, and the River Tweed, all bear the marks of wasting. To enter into particulars as to the appearances upon these shores, would be prolix, and perhaps uninteresting: But at all of them, I have been eye-witness to the rapid waste of the land, and the progressive encroachment of the sea.

Fife. If we turn our attention to the *northern* shores of the Frith of Forth, we shall find instances of the same kind no less remarkable. Of these may be mentioned the shores at the estates of the Earls of Moray and Morton, and Mr Ferguson of Raith, the damage done to numerous properties bounded by the sea, at the towns of Kirkcaldy and Dysart, and the very remarkable and fantastic appearance of the rocks, produced by the wasting effects of the sea, along the shores in the neighbourhood of Wemyss Castle; indeed, all the towns from Methil to Fifeness, particularly the Elie, Wester-Anstruther and Crail, have suffered by the encroachments of the sea, which, in some instances in this quarter, has also taken away parts of the public roads, thrown down the inclosures of gar-

dens and fields, laid waste the piers, and even undermined and carried away dwelling-houses. In the parish of Crail, some slender remains of a Priory existed so late as the year 1803, which are now washed entirely away, with its ancient gardens, &c.; but the adjoining grounds still retain the name of the Croft Lands of the Priory. The point called Fifeness, affords another proof of the desolating effects of the sea upon the land. The section of the coast here exhibits strata of a very soft and friable sandstone, with ironstone and shale. This section I have distinctly traced between Fifeness and the Carr Rock, which lies about a mile and a half off Fifeness: the whole distance between it and the shore forms a tract of shoals and half-tide rocks; and as this series of rocks, so easily worn away by the sea, can again be traced near Kingsbarns, at the opposite side of the bay, it seems extremely probable, that, at no very distant period in the history of the globe, this space between the Carr Rock and the land of Fifeness, may have consisted of firm ground. Along the shores of Balcomie and Cambo, belonging to the Earl of Kellie, and the estate of Pitmilly, considerable sums have been expended in building and re-building fences against the encroachments of the sea; and, indeed, many of the proprietors along the shores of the Frith of Forth, finding this an endless task, have, for the present, given it up as a hopeless case. At St Andrew's

the famous castle of Cardinal Beatoun, which is said originally to have been at some distance from the sea, now almost overhangs it; and, indeed, this fine ruin must ere long fall a prey to the waves: from St Andrew's, northward to Eden Water and the River Tay, the coast presents a sandy beach, and is so liable to shift, that it is difficult to trace the changes it may have undergone. It is certain, however, that within the last century, the sea has made such an impression upon the Sands of Barry, on the northern side of the Tay, that the light-houses at the entrance of that river, which were formerly erected at the southern extremity of Button-ness, have been from time to time removed about a mile and a quarter farther northward, on account of the wasting and shifting of these sandy shores, and that the spot on which the outer light-house stood early in the seventeenth century, is now two or three fathoms *under water*, and is at least three quarters of a mile within *flood-mark*. These facts I state from information obligingly communicated to me by George Clark, Esq. Master of the Trinity-House, Dundee, from the records of that corporation. From the Tay all the way along the coast of Forfar and Kincardine to Stonehaven, the shores exhibit rocks of secondary or newer formations, as sandstone and breccia, &c. and here the effects of the sea are in many places very perceptible: particularly about half a mile to the westward of the town of Ar-

Forfar and Kincardine

broath, where the public road bounds the sea shore. Within the last thirty years, the Trustees for the highways have been under the necessity of removing the road twice within the fields; and this operation it has now become again necessary to repeat, for the safety of the traveller. The shores of the estate of Seaton in this neighbourhood, and the Earl of Northesk's estate of Aithie, including the promontory called the Redhead, exhibit the most unequivocal marks of decay from the same cause; and on a very slight inspection, the continued progress of disintegration is deducible from the appearance of the shores at Montrose, the North Esk river, Johnshaven, Dunottar Castle, and the bay of Stonehaven. From thence along the shores of Aberdeen and Banffshire, with little exception, the coast consists either of extensive tracts of sand or of primitive rocks, as granite, porphyry and serpentine. The shifting nature of the sands, which, when dry, have been blown inland, and have covered nearly the whole parish of Furvie, belonging to the Earl of Errol, necessarily prevents the effects of the sea from being so easily traced as upon the softer kinds of rocks, or on alluvial grounds; and although these rocky shores do not yield so readily to the impulse of the waves, yet even the granite itself cannot withstand the continued force of the sea, which here rolls its surges upon it, in north-easterly gales, with uninterrupted violence, all the way from the coasts

Aberdeen and Banff.

of Lapland and Norway. We are not, therefore, so much surprised to find *incisions* made into the hardest rocks, exhibiting such extraordinary cavities as the Bullers of Buchan, and other striking appearances on this coast near Peterhead, as to observe its destructive effects upon the more sheltered shores of the Frith of Forth, formerly described, or those of the Moray Frith, which we are now approaching.

Elgin. After passing the river Spey, the rocks on the shores belong to the sandstone or coal formation, and here again the wasting effects of the sea become more apparent. At the ancient town of Burghhead, an old fort or establishment of the Danes was built upon a sandstone cliff, which, tradition says, had a very considerable tract of land beyond it; but it is now washed by the waves, and literally overhangs the sea. Between Burghhead and Fort George, a space of about twenty-five miles, the coast is one continued bank of sand, which has undergone very great changes from the blowing of extensive sand-banks, that has buried several hundred acres of the estate of Cubin, and covered many houses; nor have the ravages of the sea been less felt than those of the *sand-flood* in this quarter, as the old town of Findhorn was destroyed by the sea, and the site of it is now overflowed by every tide. At Fort George, the encroachments of the sea are likely to produce considerable damage upon the walls of the fort,

Inverness and Cromarty.

some of the projecting bastions, formerly at a distance from the sea, are now in danger of being undermined by the water; and it has been found necessary to construct a kind of *chevaux de frise*, to break the force of the waves before they reach the walls. The same remarks regarding the destructive effects of the sea, are also applicable to the shores of the Frith of Dornoch, and more sheltered Frith of Cromarty, and the great basin above Fort George, and even of Loch Beauly. The coast of Caithness, the islands of Orkney, and the southern parts of Shetland, consist chiefly of sandstone rocks, and from their great exposure to the sea, it is no wonder that they appear in many places to be rapidly wasting. In Orkney it deserves particularly to be remarked, that the Start Point of Sanday, which is now formed into an island every flood-tide, was, even in the recollection of some old people still alive, one continuous tract of firm ground; but at present, the channel between Sanday and the Start *Island*, as it is now called, is hardly left by the water in neap tides; and since a light-house was erected upon this Point about ten years ago, the channel appears to have worn down at least two feet. It would indeed be an endless task, to enter into minutiæ regarding the waste observable upon the western coast of Scotland, including the shires of Sutherland, Ross and Inverness, although defended from the heavier breach of the Atlantic Ocean, by the

Caithness, Orkney and Shetland.

Sutherland, Ross, &c.

Lewis, Harris, &c. Chain of Islands, consisting of the Lewis, Harris, Uist and Barra, extending about 120 miles in a north-eastern and south-western direction, and commonly called the *Long Island*, while the Isle of Sky and the Argyleshire coast are sheltered by the Western Hebrides, including the Great Islands of Mull, Jura, and Isla; yet even in the most sheltered places of this coast, as we have seen of the Friths of Forth and Moray, the sea in many places is rapidly wasting the shores. These effects, however, are not less obvious on those islands which are exposed to the direct breach of the Great Western Ocean, as, for example, on the western shores of the the Lewis and Uist Islands. In Uist, particularly, the sea has overrun considerable tracts of land, forming every tide extensive pools and many fordable channels. The extensive low link grounds, and all the sandy shores of these Western Islands, and also of Orkney and Shetland, consist almost wholly of broken or pounded shells, thrown up in the first instance by the sea, and afterwards blown by the winds upon the land.

Argyle.

Shores of Galloway and the Clyde, &c. All along the coast of Galloway, and shores of the shires of Ayr, Renfrew, and Bute, the wasting effects of the sea are no less remarkable. In Loch Ryan, for example, the whole verge of the land round the Loch is visibly wasting, and the margin of the sea is extending outwards. At the town of Stranraer, the houses along the shore had formerly gardens, between them and high-water mark, but

of late years, the inhabitants have been under the necessity of erecting bulwarks, to secure the walls and approaches to their houses. At the village of Kirkcolm, a *neck of land* called Scar-Ridge, extended into the loch about half a mile, on which cattle used formerly to graze, which is now nearly washed away, and in high tides is laid wholly under water. Observations of a similar nature occur on various parts of the shores of the Frith of Clyde, where they strike the mind with more force than perhaps in any other part of the kingdom; for here the shores are not only comparatively well sheltered, but the tides are so languid as to rise only from nine to eleven feet perpendicular, while the corresponding tides on the eastern coast of Great Britain, rise from fourteen to sixteen feet.

Observations upon the wasting of the land by the encroachment of the sea, might, with great propriety, be made upon the shores of Ireland, of which I have seen many instances on the western, northern and eastern coasts, from Loch Swilly, in the county of Donegal, to the Tusker Rock, off the coast of Wexford. But, without enlarging upon these shores, we shall now turn our attention to the coast of England, which, with the opposite shores of Holland and France, form the apices of the German Ocean and British Channel. From the more soft and yielding matters of which these shores are formed, particularly those of England, Ireland. England.

which are at the same time exposed to the violent attacks of the sea in storms from the north-eastern and south-western directions, the wasting effects of the sea are altogether so very remarkable, that it may in general be affirmed that these shores are in a progressive state of decay. Beginning with the north-eastern coast, examples of this will suggest themselves to the recollection of those who are acquainted with the shores of Northumberland, Durham and Yorkshire, as at Holy Island, for example, and the shores near Bamborough Castle, where the sea has made considerable inroads upon the land. Tynemouth Castle, situated at the entrance of the river Tyne, which now, in a manner, overhangs the sea, had formerly a considerable extent of land beyond it; Tynemouth Head being composed of a soft sandstone, is gradually worn away by the action of the sea and the effects of the weather, and every season it falls down in such quantities, that the degradation is quite observable to the inhabitants of the town of Tynemouth. Upon the southern side of the entrance to the river Tyne, many acres of land have been washed away from the extensive ebb called the Middens: the same thing has happened along the whole shores of the county of Durham, particularly between the rivers Tyne and Weir, where the coast is chiefly composed of a soft friable limestone; and indeed the land is obviously in a state of waste all the way to the Tees. Here the an-

Northumberland.

Durham.

cient borough of Hartlepool presents a wonderful example of the encroachment of the sea: it is built upon a projecting point of land, which is fast approaching to the state of an island. Part of the borough lands are every season disappearing, and the tide now flows within the gates of the town. The wasting effects of the sea on the soft friable stone of the isthmus on which the town of Hartlepool stands, is altogether so strikingly remarkable, that it seems curious and highly interesting to the eye of a stranger. On the southern side of the great sand-banks forming the mouth of the Tees, we enter upon the coast of Yorkshire, which extends to the estuary of the Yorkshire River Humber, being upwards of a hundred miles. This coast consists chiefly of sandstone and chalk-hills, and in many places exposes a precipitous face to the sea, which is acting upon it, and in general producing its rapid destruction; of this, many examples are familiar to those on the spot, particularly in the neighbourhood of Whitby and Scarborough. For a few miles both on the northern and southern side of Flamborough-head Lighthouse, the section of the coast is almost perpendicular, and consists of chalk, intermixed with portions of clay. At the eastern extremity, or *pitch of the head*, the chalky cliff is about seventy feet in height: from this point the coast declines all the way to the Town of Bridlington, and from

thence to Dimblington Cliff, near the entrance to the Humber, it is a low sandy shore. From what has been already stated of the effects of the sea upon the hard or more compact shores of Scotland, it is easy to imagine what its operation must be on the line of coast just described. Accordingly, the inhabitants at Flamborough-head, and indeed all along the Yorkshire coast, are too often kept in mind of this, by the removal of their *land-marks* and inclosures; and there are many traditions of churches, houses, and whole fields having been overrun by the sea in the neighbourhood of Hornsea, Kilnsea, and the Spurn Point on the northern side of the Humber. The widely extended mouth of this estuary, and the manner in which it is cumbered with sand-banks off the coast at Clea and Saltfleet in Lincolnshire, and indeed the appearance of the coast all the way to Boston, shews that much of the land has been swallowed up or overrun by the sea; of which there are many striking proofs, both of ancient and modern occurrence.

Lincoln and Norfolk.

The same remarks are also applicable to the great ebb, called the Wash, forming the entrance or navigation to the harbours of Boston and Lyne. Here, it would appear, that the sea has made a breach through the chalk hills, which are observable on each side of the Wash, in the counties of Lincoln and Norfolk, where it is obvious, that the land has at one time extended further in-

to the sea, and is at present undergoing the process of actual waste. Perhaps evidence of this may also be drawn from the works of *William of Malmesbury*, who represents the whole of the Fens of Lincoln to have been in a state of high cultivation in the *eleventh century*. But certainly a most unequivocal proof of this is afforded from the discovery by Sir Joseph Banks and Dr Joseph Correa, mentioned in the 89th volume of the Philosophical Transactions, of the remains of a *sub-marine forest* on this coast, now several fathoms under water, where the roots, boles and branches of trees, particularly of the birch, of large size, were observed: from the account of the fishermen of this coast, these appearances are to be seen for many miles along the shore, in the form of a range of small islets; and trees have been often found, the timber of which was so fresh, as to be fit for economical purposes. The inhabitants of the country likewise represent, that at one time the parish-church stood greatly within the present sea-mark, and that the walls of houses, of a former village, have been seen at low ebbs; and they allege, that even the *clock* of the present parish-church, is the same that was in the church, the foundations of which are now overflowed. It seems therefore probable, and indeed it is of the greatest importance to the drainage of this tract of country to know, that the present state of the Fen Country arises from the encroachments of the

Fens of Lincoln.

sea, occasioned by the *silting* or filling up to a certain degree of the alveus or bed of the German Ocean, rather than from the gradual retreat, or subsiding of these waters; and that the sea, notwithstanding some anomalous instances of recession, which shall afterwards be noticed, is invariably trenching upon the land. In exploring and comparing the present with the ancient state of our shores, we cannot enough lament the inaccuracy of the older maps and charts of our coast; and every one must rejoice at the prospect this country has, of soon possessing maps founded on the "Trigonometrical Survey of Great Britain," now in progress, under the direction of the Board of Ordnance. This great national work, will enable future generations with accuracy to appreciate and compare, the effects which we are now describing.

Suffolk and Essex.

Proceeding southward, we next traverse the coast of Suffolk and Essex, where numerous instances occur of ravages which the sea is making upon the shore: It has already been ascertained, that the sand-banks of Yarmouth Roads have, of late years, considerably altered, and that the depth of water is, upon the whole, lessened, a circumstance most severely felt by the mariners on this part of the coast, and indeed all the way to the Thames, the entrance of which is now so much encumbered with deposited matters, in the form of sand-banks, as to render that navigation

extremely difficult, irksome and hazardous. Some pretty extensive additions have also been made to the land in this neighbourhood, at the junction of the rivers Alde and Butley, in the great gravelly beach which extends no less than about eight or ten miles in length, varying in breadth from a few hundred feet to about a mile; and similar appearances are to be found on this coast, as at Harwich, near the confluence of the rivers Stour and Ipswich, where a considerable addition has been made to the land on the southern side of Landguardfort: yet these, and other examples of the same kind, are trifling, in proportion to the astonishing effects of the sea in *destroying* the land in this very neighbourhood. Near Leostoffe, Dunwich, and Aldborough Castle, on the Suffolk coast, the sea is daily making impressions upon the land, which is apparent to the observation of every one acquainted in the slightest degree with that coast, and is at some places severely felt by the proprietor, or even by the tenant during the short endurance of his lease-hold. At the Naze Tower, near Walton, and indeed all along the coast of Essex, the same appearances are no less obvious. Crossing the numerous sand- Kent. banks and shoals which greatly encumber the mouth of the River Thames, to the Kentish coast, we are every where presented with instances of the degradation of the land by the encroachment of the sea. From Sheerness along the

shore of the Isle of Sheppey, and from the entrance of the River Swale to Margate and Ramsgate, at various places, very large portions of the chalky cliffs are continually giving way to the sea. At Sheppey Island, Thanet and Sandwich, there are proofs of the land gaining somewhat upon the sea: of this, the Goodwin and other sand-banks may also be considered as examples; but these cases, arising from the shape of the coast, and the set of particular currents of the tide, are rather so many evidences of the *silting* up of the *alveus* or bed of the ocean, and shall be afterwards alluded to as proofs of the consequent tendency of the sea to overflow its banks. But to continue, it may further be noticed, that the Streets of Deal are often laid under water, and houses there have occasionally been washed down by the sea; and, indeed, the wasting effects are very striking all along this coast, and the opposite shores of France, the Netherlands, and Holland.

British Channel.

At Romney Marshes, in the British Channel, labourers are constantly employed attending and repairing the fences and sea-dikes of these low shores. On the precipitous shores from Deal to Dover, Folkstone and Hithe, large portions of the chalk cliffs are frequently undermined and carried away; particularly at the South Foreland and Cliffs of Dover, where I happened to witness the effects of the recent fall, some years ago, of an immense quantity of these extraordinary chalk

cliffs, the ruins of which appeared to cover several acres of ground, and must have contained many thousands of tons. A fall of this kind, near Beachyhead, on the Sussex coast, is noticed in a paper by Mr Webster in the Transactions of the Geological Society: the portion which gave way extended 300 feet in length, and was 70 or 80 in breadth; a clergyman who happened at the moment to be walking on the spot, observing the ground giving way, had just time to escape when the whole fell with a dreadful crash. Shoreham and Brighton also afford many examples of this kind, particularly the latter, "where a whole street has within these few years fallen into the sea." In the same manner, the opposite coast of France is understood to be acted upon; and the numerous Islands lying off that coast and the coasts of Germany and Holland. I might also extend these observations to the shores of Hampshire, Dorset, Devon, Cornwall, particularly to the Isles of Wight and Portland, and the Scilly Islands; the wasting of the land, and the encroachment of the sea, being every where remarkable, and always in proportion to the nature of the strata or rocks composing the coast, whether alluvial, chalk, limestone, sandstone or granite.

St George's and Bristol Channels.

Nor are these effects of the sea confined to the shores of the German Ocean and British Channel; for the wasting of the land is no less remarkable in St George's Channel and the Irish Sea, in-

cluding the coast of Ireland on the one side, and on the other, the shores of Wales, Lancashire, Westmoreland, and the counties of Dumfries, Kirkcudbright, &c. where neither the rocky coasts, and exposed situations of the Islands of Anglesea, Man, Copland, Craig of Ailsa, and the Islands of Cumbrae, nor the sheltered and alluvial shores of the Bristol Channel, are exempted. A striking example of this has been obligingly communicated to me by CHARLES STOKES, Esq. Secretary of the Geological Society, which occurs off Swansey, where the receding tide exposes a large deposite of trees, within 60 yards from high-water mark. The encroachment of the sea upon the Welch coast, is briefly noticed by ARTHUR AIKIN, Esq. in his interesting Journal and Mineralogical Tour through North Wales, p. 229. &c. in which he enumerates several examples of this along the broken and irregular shores between the Severn and the Mersey. Even the granitic coast at Dublin Bay, and indentations of the sandstone shores at Liverpool and Lancaster, and the more extensive Frith of the Solway, are also subject to the unvarying destructive effects of the sea upon the land.

Swansey.

North Wales.

Liverpool and Dublin.

Solway Frith.

Were proofs of the generality of the wasting effects of the sea upon the land to be taken from foreign countries, we should find them no less striking. Whether we look to those coasts and islands which are washed by the expanse of th

Atlantic Ocean, or consider the more sheltered shores, as those of the Adriatic, we shall find an *almost* invariable tendency to the enlargement of the margin or boundary of the sea.

Observations to this effect have been obligingly communicated to me by a gentleman resident at the island of Granada, who is also well acquainted with Barbadoes, and all the West India islands to *sea-ward*, commonly called *Leeward Islands*. On several of these he states, that the sea is making a visible impression, and particularly mentions, that, of late, one side of a street in the town of Granville, in the island of Granada, has been washed away by the sea. West Indies. Granada.

A gentleman who visited the city of Venice and the shores of the Adriatic in the summer of 1816, writes me, that the Venetians believe, and confidently assert, that their ancient city, founded about 1400 years since, must by this time have been almost entirely washed away and laid in ruins by the increasing advancement of the sea, had it not been protected and defended by a great mole or *sea-wall* and embankment, which became necessary and has now been erected about eighty years. Any particular description of this mole is perhaps abstractly more a matter of interest to the engineer than to the geologist; but from the magnitude of the work, and the direct purpose to which it is applied, it is presumed, that, even here, its general outline may be given, as affording some additional interest to the Venice and the Adriatic.

subject. This great work is situate about fifteen miles southward from the city of Venice, is built across part of the apex of the Adriatic Sea, and is almost three miles in extent. In part of its course, it is carried through a morass, from L'Isle de Chiusa on the west, along L'Isle de Murasse to the Bocca di Porto on the east. The depth of the foundations of this stupendous work varies according to the nature of the bottom, and the depth of the water, which at some places is said said to be sufficient to float a frigate quite close to the wall. The masonry terminates in a wall of about ten feet in height, with a walk of four feet in breadth, forming its thickness at the top, from which this immense wall and embankment is seen to slope and fall majestically into the Adriatic. This proud monument of Venetian greatness, which interrupts the natural current of the water, is the scene of great contest, in stormy weather, between the fury of the waves and the *obstinate gravity* of the ponderous materials of which the greater part of it is composed, and which are also firmly cemented together with Puzzolano-mortar. The sloping face of the wall in some places extends fifty feet in breadth to the water's edge of solid masonry, beyond which is an irregular stratum or heap of mound stones, consisting of large loose blocks, which are notwithstanding at times set in motion, and the smaller pieces thrown over the wall by the waves.

Conclusion.

Without further examples, however, we may for the present venture to assume, that the disintegrating and wearing effects of the waters of the ocean are *general.* Whether we contemplate them upon the land by the immediate and powerful impulse of the waves at the base of a rocky shore, or, with the elegant and profound illustrator of the Huttonian Theory, trace it in the form of rain, rills and torrents, in the higher regions, we shall find its effects all tending to one unvarying principle, producing the degradation of the land, and consequent tendency to filling up at the bottom of the sea; while, at the same time, from the magnitude and extent of the surface, and other occult causes, we are not aware of the elevation of its level in any sensible degree. Nature seems to have created a kind of compensating power to counterbalance the seeming conflict of the elements of Earth and Water: for while the ocean appears to be extending its surface, it seems also probable that the quantity of its waters are upon the whole lessened, and that part of them undergoes a complete and permanent change of form after the process of evaporation; and that the earthy particles continually accumulating at the bottom of the sea, have a direct tendency not only to preserve a uniform level, but even in some instances to make the water overrun what we have been accustomed to consider its boundary. If we attentively inquire into the *generality* of the wasting effects of the sea upon the margin of the land,

it will perhaps appear, that the instances in which the sea can be considered as just taking a portion of land from one part, while it adds in like proportion to another part of the coast, will come far short of the instances of detrition in all quarters of the globe.

Having now pointed out, from actual observation on about one-half of the coast of Ireland, and on all parts of the shores of Great Britain, from the *Scilly Islands* to *Unst*, or northmost of the Shetland Islands, That the land, on the margin of the sheltered bays and friths as well as on the most exposed promontories and open shores, is undergoing the process of waste and decay from the impulse and action of the sea; I shall in a future paper, with the indulgence of the Society, endeavour to shew that the Cause of this effect, particularly on the shores of the German Ocean and British Channel, is, in a good measure, owing to the immense quantity of debris which must be accumulating, at least to a certain depth, in the bottom of the ocean.

XXIX. *Geological Remarks on the Cartlane Craig.*

By Dr Macknight.

(Read 12th February 1814.*)*

It is remarkable, that amongst the phenomena of the mineral kingdom, on which the two geological theories now in discussion, have been founded, there should be so many that do not admit of an unequivocal or exclusive application to either side of the question at issue. A great number of these appearances may be explained on the principles of both systems, so as to render it a matter of doubt with some enquirers, to which of them we ought to give the preference; nor is there perhaps a single fact yet observed, which is acknowledged on all sides as possessing distinctly the character of what may be called an *experimentum crucis*, to decide the faith of mineralogists.

Of the former description here alluded to, I have lately found a striking instance, in the Cartlane Craig, which is a vast chasm, in the sandstone formation, above Lanark, traditionally celebrated as one of the places where the heroic but unfortunate WALLACE concealed himself from the search of the English. It is evidently formed by the under side or projecting shoulder of a round backed mountain-mass, somehow detached from the body or upper part. The general line of this enormous and singular rent, which runs nearly in the direction of N. E. and S. W., is that of the segment of a circle, sweeping to a distance of at least three-fourths of a mile from the one extremity to the other. Its greatest

The whole extent of the Cartlane Craig, along its edges and steep faces, particularly on the lower side, is richly fringed and beautifully clothed with plantations and brush-wood, so as to exhibit one of the finest and most romantic pieces of natural scenery, that can be imagined. In spite, however, of this covering, and of the waste which must have gone far in the course of ages, to disfigure the face of the rock, and destroy the traces of its fracture, the more remarkable features of this extraordinary mineral appearance, are still discernible on the slightest inspection. It presents a succession of projecting and re-entering angles, reaching from the top to the bottom of the solid front, which are most distinctly observed towards the centre or highest part: each projection on the one side having its correspondent recess on the other, and the opposite faces or edges of the disrupted strata shewing their original continuity.

These circumstances, render it probable, that the chasm in question has owed its existence to the operation of some cause, not of a slow and silent kind, as the wearing of water, or the decomposition of the rock, but more sudden and violent in its action: and to explain it satisfactorily, I would now propose, as a geological problem, of no inconsiderable curiosity and interest.

For this purpose, it must be further stated, as a part of the description of the Cartlane Craig, that near the middle of the great fissure, we find the channel of the stream crossed, by a mass of greenstone, or flœtz-trap rock, which traverses the strata in a direction almost perpendicular to the course of the hollow at that place. In the neighbourhood of the greenstone, smaller veins or portions of the same substance may be traced running in a similar direction, and exhibiting at some places the characters of basalt. The immediate connection of these smaller branches or veins with the largest mass, is concealed by the soil and coppice-wood, and debris in the bed of the water; but in the language of the Huttonian School, they would be described as shooting from it.

Now, on the principles of the igneous theory, the presence of greenstone in the position which it occupies here, affords at once the solution required; and the Cartlane Craig becomes an example on a large scale, of disruption and dislocation produced by a melted or fluid mass, bursting upwards from the bowels of the earth.

On the other hand, the first part of the description I have given, clearly resolves this phenomenon into the effect of what is called in the aqueous theory, subsidence, of which it possesses all the data to form a case. Such an explanation, every appearance and circumstance connected with the

subject, inclines me strongly to prefer, on the following grounds, which I submit with deference to the observation and judgment of geologists.

I. Admitting the fusion of greenstone by heat, the mass in this case, considered as a mechanical power, seems totally inadequate to the effect produced; as it does not exceed a few feet in thickness, while the mass of strata displaced, is almost a square mile in extent, with a depth of at least a hundred yards.

II. The relative position of the mass or vein, so far as it appears, is incompatible with the supposition of its having been the agent in this displacement. Had the greenstone followed the direction of the great chasm, appearing every where along the bottom, or in its vicinity, such an inference might have been plausible. But far otherwise, as already noticed, it runs almost directly across the hollow; so that the fissure which has taken place, is nearly at right angles to that which the laws of mechanism would teach us to expect, from the presumed disruptive force of the greenstone.

III. The strata fractured and separated, exhibit no marks of having been burst asunder by the

power of explosion; nor indeed any appearance, but what would naturally be found, in a case of subsidence or desiccation. Those on the upper or mountain side, preserve throughout their original position, which, with little exception, is almost horizontal, with their edges presented to the eye; and they seem to run backwards undisturbed into the body of the mountain: while, on the lower, or detached side, they have precisely the appearance and inclination which might be expected, if they had fallen off or slipped down from the higher mass, of which they originally formed a part. In confirmation of this hypothesis, it may be observed, that the precipitous front on the mountain-side, approaches in general much nearer to the perpendicular, than on the opposite side, which shelves so considerably that I was able at one place, not far from the centre, to clamber from the bottom up to the top.

IV. Whether the Cartlane greenstone has been an eruption from below, or a deposition from above, or in whatever way we may suppose it to have been formed; every thing in the appearance and position of the rock, demonstrates, that the greenstone itself also, must have originally been a part of the great mountain-mass, previous to the period of its being rent as we now see it. In fact, the greenstone on the one side has evidently

been broken off from the opposite, as well as the sandstone. If so, the conclusion I have drawn, is unavoidable.

V. To complete the evidence of this explanation, all the circumstances which strike the eye, in surveying the neighbourhood of the Cartlane Craig, and especially the great declivity towards the Clyde, which runs at a level of several hundred feet below, decidedly favour the opinion, that the separation of the rocky mass has been occasioned by its sinking on that side, where it had been left without support. From the lowest extremity of the great opening, to the bed of the Clyde, at the nearest point, there is a rapid descent of half a mile; and the course which the stream of the Mouse must have followed along the base of the dislocated mass on the outside, had no dislocation taken place, is too obvious to escape notice at first sight. This apparently original course, though unobstructed by the fundamental rock, is indeed entirely blocked up by a ridge of considerable height, on which the house of Baronald stands. It is plain, however, that this ridge has been formed only by the debris from the dislocated rock filling up the hollow behind it, and accumulating in the progress of time; so that the water of the Mouse, after having probably been collected to some depth, in a large bason, still ex-

isting on the north-east of Baronald House, and presumed to have been the commencement of the original course, had been forced to work its passage through the present channel, which the displacement of the strata had opened to it, and which it has no doubt worn and deepened.

Such are the reasons which induce me to adopt the explanation of this appearance, suggested by the principle of the aqueous theory. It may also be thought, that the effect of earthquake might be taken into account, as assisting the failure of support on the lower side. But without insisting further on such topics, I leave the solution now proposed, to the decision of future observers, whom curiosity may afterwards lead to visit a scene so remarkably striking and attractive to the eye of taste as well as of science. Points, in fact, of this nature, will not be decided satisfactorily, without the most accurate observation and experienced judgment, in the progress of geological knowledge.

I have only to add, that the Cartlane sandstone may be described as belonging to the class of rocks immediately subsequent to grey-wacke, in the order of succession. It has in general, all the characters of old red sandstone, approaching to grey-wacke; and it occurs alternating with that substance, among the undermost strata of the formation, as may be seen in the lower country along

the banks of the Clyde above Lanark. The fragments it contains when coarse-grained, are angular pieces and rolled masses, of quartz, felspar, grey-wacke, clay-slate, jasper, flinty-slate, &c., often so large, that some of the beds may be regarded as conglomerates. But the greater portions of the strata are fine granular, composed of quartz, felspar, and mica, minutely aggregated, in some varieties without a base, in others with a cement of clay; and the mixture is so pure, as to render these varieties excellent specimens of what Professor Jameson is inclined to consider as true chemical depositions. Quartzy-sandstone also occurs, with facettes of felspar.

In this formation, most of the rocks exhibit numerous scales of mica. We find in others, specks of embedded copper-pyrites. Lime, too, frequently appears in the lowest strata, pervading the substance of the rock, as a kind of base, or penetrating it in the form of cotemporaneous calc-spar veins. In the former case, we have what may be called arenaceous limestone, which may be found in the bed of the river above Clyde Bridge. Veins of heavy-spar sometimes occur. The variety of colours in the different strata, seems to depend on the greater or less abundance of iron.

With regard to the trap-rock, of which the position has been described, its oryctognostic characters do not exhibit much variety. The greatest mass, is a compact greenstone, intermixed with

calc-spar: the smaller veins approach to basalt, with olivine and augite. Other varieties are intermediate between basalt and clinkstone; and contain small portions of blackish-coloured clay, together with calc-spar, crystals of felspar, and little shining facettes of hornblende.

The examination of the Cartlane Craig, will always interest the mineralogist; and the fatigues of Mr LIGHTFOOT, in clambering over its broken rocks, were rewarded by the discovery of several rare and curious plants.

XXX. *Account of the Irish Testacea.*

By Thomas Brown, Esq. F.L.S. M.W.S. M.K.S. &c.

(Read 16th Dec. 1815.)

SIR, *Naas Barracks, Ireland,*
20*th August* 1815.

For the information of the Wernerian Society, I herewith send you an enlarged Catalogue of the Irish Testacea. You will observe I have made a considerable addition to that I sent on the 14th November 1814.

With the exception of a few species, collected in places I have never visited, by persons on whose veracity I can depend, they have all come under my own observation.

In the catalogue will be found several new species, which have not hitherto been described, drawings of which I have annexed.

My residence having been in situations remote from the coast, has prevented me from making the list of the marine species more complete. The variety to be met with in one day on the beach of Dublin Bay and Portmarnock, exceeds any thing I ever before witnessed. And it appears to me, that the Land and Fresh-water Testacea, are more plentiful in Ireland than in England or Scotland, as almost every ditch abounds in shells; and I have frequently seen old ditches cleared out, with a solid mass of decayed shells, from twenty inches to two feet thick at bottom.

I have the honour to be,

SIR,

Your most obedient humble servant,

THO[s]. BROWN,
Captain Forfar Regiment.

To Professor JAMESON, President of the Wernerian Society, *&c. &c. &c.*

ACCOUNT

OF THE

IRISH TESTACEA.

Order I.

MULTIVALVE SHELLS.

CHITON.

1. fascicularis. Linn. Trans. viii. p. 21. t. 1. f. 1.—Wood, Gen. Conch. p. 16. t. 2. f. 6. On oysters from Killinchy, Lough Strangford; plentiful.
2. marginatus. Linn. Trans. viii. p. 21. t. 1. f. 2.—Wood, Gen. Conch. p. 21. t. 3. f. 4. Pigeon House, Dublin Bay; plentiful.
3. lævis. Pennant, Brit. Zool. 4. t. 36. f. 3. Rathgarmont, Lough Strangford, on oysters; rare.

LEPAS.

1. Balanus. Donovan, Nat. Hist. Brit. Shells, t. 30. f. 1.—Wood, Gen. Con. p. 43. t. 7. f. 3. Dublin Bay, Portmarnock, and Killough.
2. Balanoides. Donovan, Br. Shells, 36. f. 2.—Wood, Gen. Con. 44. t. 7. f. 1. Pigeon House, Killinchy, and Killough.
3. Tintinnabulum. Donovan, Brit. Shells, t. 148.—Wood, Gen Con. 38. t. 6. f. 1, 2. On drifted wood at Howth.

4. rugosa. Wood, Gen. Con. 41. t. 6. f. 4.; Donovan, Brit. Shells, t. 160. L. borealis.—Dublin Bay, and Portmarnock; common.

5. intertexta. Donovan, Brit. Shells, t. 36. f. 1.—Wood, Gen. Con. 57. t. 9. f. 5. L. verruca. Portmarnock, adhering to the Buccinum undatum; rare.

6. anatifera. Donovan, Brit. Shells, t. 7.—Wood, Gen. Con. 65. t. 11. Fixed to rotten wood at Howth.

PHOLAS.

1. Dactylus. Donovan, Brit. Shells, t. 118.—Wood, Gen. Con. 77. t. 13. f. 1, 2, 3. One valve, about $3\frac{1}{4}$ inches broad, at Howth, by Mr O'Kelly.

2. candida. Donovan, Brit. Con. t. 132.—Wood, Gen. Con. 79. t. 14. f. 3, 4. Dublin Bay, rare.

3. crispata. Donovan, Brit. Shells, t. 62. & t. 69. P. parva. Portmarnock, rare; Belfast Lough, not uncommon.

Order II.

BIVALVE SHELLS.

MYA.

1. truncata. Donovan, Brit. Shells, t. 92.—Wood, Gen. Con. 90. t. 17. f. 1, 2. Dublin Bay, and Portmarnock; very common.

2. arenaria. Donovan, Brit. Shells, t. 85.—Wood, Gen. Con. 91. t. 17. f. 3. Buried in the sand at Ring's End, Dublin Bay, and at Portmarnock; common.

3. declivis. Donovan, Brit. Shells, t. 82.—Wood, Gen. Con. 93. t. 18. f. 2, 3. *bene.* Dublin Bay; and of large size in Belfast Lough.

4. prætenuis. Donovan, Brit. Shells, t. 176.—Wood, Gen. Con. 94. t. 24. f. 7, 8, 9. Belfast Lough; rare.

5. pellucida. (Plate xxiv. fig. 1.) Shell oblong-ovate, white, pellucid, thin, and rather convex; umbo small, placed nearly central; posterior side a little truncated, and a little turned to one side; anterior side rounded; covered with a fine transparent olivaceous epidermis; pretty strongly wrinkled concentrically, the wrinkles more strong and sharp, and rather rugose, at each end; the outside is covered with a fine waved striæ at each end, but smooth towards the centre of the valves; from the umbo an oblique furrow runs to the end of the anterior slope; in each valve is a spoon-like cavity, sloping downwards, to which the cartilage is fixed. Inside of a very fine pearlaceous hue, and smoothly wrinkled, corresponding with the outside.

Breadth, $1\frac{1}{4}$ inch; length, $\frac{5}{8}$ths of an inch.

Two opposite valves, of different sizes, of this shell, were found by Miss Hutchins at Bantry Bay, and are now in the cabinet of Dr Taylor of Dublin, who obligingly favoured me with them, to describe and draw from.

6. margaritifera. Donovan, Brit. Shells, t. 73.—Wood, Gen. Con. 107. t. 23. f. 1, 2, 3. In the river Slany, Ennescorthy.

7. inæquivalvis. Montagu, Test. Brit. 38. Sup. t. 26. f. 7.—Linn. Trans. viii. 40. t. 1. f. 6. Dublin Bay, and Portmarnock.

SOLEN.

1. Vagina. A striking characteristic of this shell, which has not been noticed by any author, is, that the *epidermis* on each valve extends about half an inch beyond the valves, on the sides farthest from the hinge.—Donovan, Brit. Shells,

t. 101. S. marginatus.—Wood, Gen. Con. 119. t. 27. f. 1. Dublin Bay; plentiful.

2. Siliqua. Donovan, Brit. Shells, t. 45.—Wood, Gen. Con. 118. t. 26. f. 1, 2. Dublin Bay, and Portmarnock; very common.

3. Ensis. Donovan, Brit. Shells, t. 50.—Wood, Gen. Con. 122. t. 28. f. 1, 2. Dublin Bay, and Portmarnock; common.

4. Legumen. Donovan, Brit. Shells, t. 53.—Wood, Gen. Con. 124. t. 28. f. 4, 5. Dnblin Bay, plentiful, and of a very large size, measuring 3½ inches in breadth. This is a rare British shell.

5. antiquatus. Donovan, Brit. Shells, t. 144.—Wood, Gen. Con. 125. t. 29. f. 3. One valve was found at Portmarnock.

6. vespertinus. Donovan, Brit. Shells, t. 41. f. 2. Tellina variatabilis.—Wood, Gen. Con. 135. t. 33. f. 2, 3. Bantry Bay, attached to the Ostrea edulis.

7. minutus. Montagu, Test. Brit. p. 53. t. 1. f. 4.—Wood, Gen. Con. 139. t. 34. f. 5, 6. Portmarnock, adhering to the roots of fuci.

TELLINA.

1. Ferröensis. Donovan, Brit. Shells, t. 60. T. trifasciata.—Wood, Gen. Conch. 164. t. 45. f. 1. Dublin Bay, and Portmarnock; very common. This beautiful shell is very rare on the British coasts.

2. donacina. Linn. Trans. viii. p. 50. t. 1. f. 7.—Wood, Gen. Conch. 161. t. 45. f. 5. Bantry Bay, and one valve at Portmarnock; rare.

3. jugosa. (Plate xxiv. fig. 2.) Shell ovate-oblong, convex, opaque, and strong; with numerous very sharp, elevated, concentric ridges, not regular, but somewhat waved and broken at intervals, and feel rough to the touch: the interstices are decussated, with extremely mi-

nute, concentric, undulated striæ; the lateral more regular, and diverging from the apex to the base, and can only be distinctly seen by means of a strong lens: umbo rather small, and placed considerably to one side: hinge with two central teeth and one lateral one in each valve; in the left valve is a large, broad, bifid, reflected, elevated tooth, which bends outwards, pointing to the umbo, two-thirds of which rises above the margin of the shell; the other tooth is very thin, and runs obliquely alongside the lateral tooth, which rises at the apex, and obliques towards the anterior slope, over which is placed the ligament: in the right valve one tooth is oblong, with a spoon-like cavity in its centre; the smaller tooth similar to that in the opposite valve, but somewhat stronger and obtuse; the lateral tooth the same as in the left valve: inside of a yellowish-white, with numerous glassy circular spots, and a very large muscular impression, extending from the margin (which is plain and glossy) two-thirds across the shell: anterior slope much produced; posterior slope rounded. On the outside, a subulate depression runs from the apex to the base, in an oblique direction, near the anterior slope. Length one inch; breadth one inch and three-eighths.

A complete shell and odd valve, were found by Miss Hutchins in Bantry Bay, and are now in the cabinet of Dr Taylor of Dublin.

4. depressa. Donovan, Brit. Shells, t. 163.—Wood, Gen. Con. 171. t. 45. f. 3. Dublin Bay, and Portmarnock; not uncommon.

5. Fabula. Donovan, Brit. Shells, t. 97.—Wood, Gen. Con.

156. t. 45. f. 4. Dublin Bay, and Portmarnock; common.

6. tenuis. Donovan, Brit. Shells, t. 19. three smaller figures.—Wood, Gen. Con. 155. t. 44. f. 3, 4. Dublin Bay, and Portmarnock; common.

7. Radula. Donovan, Brit. Shells, t. 130. Venus borealis.—Wood, Gen. Con. 183. t. 42. f. 4, 5. Dublin Bay, and Portmarnock; common.

8. crassa. Donovan, Brit. Shells, t. 103. T. rigida.—Wood, Gen. Con. 186. t. 40. f. 1. Dublin Bay; very rare.

9. rotundata. Montagu, Test. Brit. 71. t. 2. f. 3.—Wood, Gen. Con. 187. Bantry Bay; rare.

10. flexuosa. Donovan, Brit. Shells, t. 42. f. 2. Venus sinuosa.—Wood, Gen. Con. 188. t. 47. f. 7, 8. Dublin Bay, and Portmarnock; sparingly.

11. solidula. Wood, Gen. Con. 193. t. 46. f. 2.—Montagu, Test. Br. p. 63. Dublin Bay, and Portmarnock; very common.

12. cornea. Donovan, Brit. Shells, t. 96.—Wood, Gen. Con. 196. t. 46. f. 3. In a stream in the Bog of Allen, near Clonooney; and plentiful in the Grand Canal.

13. amnica. Donovan, Brit. Shells, t. 64. f. 2. T. rivalis.—Wood, Gen. Con. 153. t. 47. f. 6.—In a stream near Clonooney: in the Grand Canal; and in the Liffey; plentiful.

CARDIUM.

1. medium. Donovan, Brit. Shells, t. 32. f. 1.—Wood, Gen. Con. 211. t. 50. f. 3. One valve from Rathgarmont, Lough Strangford.

2. exiguum. Donovan, Brit. Shells, t. 32. f. 3.—C. pygmæum. Wood, Gen. Con. 212. In sand from Portmarnock.

3. aculeatum. Donovan, Brit. Shells, t. 6.—Wood, Gen. Con.

207. t. 51. f. 1. Dublin Bay, and Portmarnock; very common, and of a large size.

4. echinatum. Donovan, Brit. Shells, t. 107. f. 1.—Wood, Gen. Con. 208. t. 49. f. 1, 2. Dublin Bay, and Portmarnock; very common.

5. ciliare. Donovan, Brit. Shells, t. 32. f. 2.—Wood, Gen. Con. 209. t. 49. f. 3, 4. Dublin Bay, and Portmarnock; rather scarce.

6. lævigatum. Donovan, Brit. Shells, t. 54.—Wood, Gen. Con. 222. t. 53. f. 1, 2.

7. edule. Donovan, Brit. Shells, t. 124. f. 2.—C. rusticum. Wood, Gen. Con. 226. t. 55. f. 4. Common on most sandy shores. I found a valve in Dublin Bay, one inch and six-eighths in in length, and two inches and a quarter in breadth. They are common of this size at Wexford.

MACTRA.

1. Stultorum. Donovan, Brit. Shells, t. 106.—Montagu, Test. Brit. p. 94. Dublin Bay, and Dundrum Sands; very common, and in the former place of a very large size, and very strong.

2. solida. Donovan, Brit. Shells, t. 61.—Montagu, Test. Brit. p. 92. Dublin Bay, plentiful.

3. truncata. Donovan, Brit. Shells, t. 126.—M. subtruncata. Edinburgh Encyclopædia, art. Conchology, p. 93. t. 205. f. 14. Dublin Bay, and Portmarnock; not uncommon.

4. subtruncata. Montagu, Test. Brit. p. 93.—Edinburgh Encyclopædia, art. Conchology, p. 93. t. 205. f. 15. Dublin Bay, and Portmarnock; sparingly.

6. Listeri. Donovan, Brit. Shells, t. 64. f. 1. Tellina plana. —Pennant, Brit. Zool. No. 52. Venus borealis. Dublin Bay, rare; Babrigging, plentiful.

7. Boysii. Linn. Trans. 8. p. 72. t. 1. f. 12.—Montagu, Test. Brit. p. 98. t. 3. f. 7. Portmarnock; rare.

8. lutraria. Donovan, Brit. Shells, t. 58.—Linn. Trans. 6. t. 16. f. 3, 4. Dublin Bay, and Portmarnock; very common.

DONAX.

1. Trunculus. Donovan, Brit. Shells, t. 29. f. 1.—Montagu, Test. Brit. p. 103. Dublin Bay, Portmarnock, and Dundrum; very common.

2. denticulata. Donovan, Brit. Shells, t. 24. Don. crenulata.—Montagu, p. 104. One very small valve in sand from Portmarnock.

VENUS.

1. verrucosa. Pennant, Brit. Zool. 4. t. 54. f. 48. A. Venus erycina.—Donovan, Brit. Sh. t. 44. & t. 115. V. cancellata. Wexford; rare.

2. Casina. Linn. Trans. viii. p. 79. t. 2. f. 1.—Pennant, Brit. Zool. 4. t. 54. f. 48. Dredged at Bray, where it is not uncommon.

3. fasciata. Montagu, Test. Brit. p. 110. V. paphia.—Donovan, Brit. Sh. t. 170. Dublin Bay, and Portmarnock; rare.

4. sulcata. Linn. Tr. 8. p. 81. t. 2. f. 2. Dredged at Bray.

5. Gallina. Donovan, Br. Sh. t. 68. V. striatula.—Montagu, Test. Br. p. 113. V. striatula. Dublin Bay, and Portmarnock; common.

7. Islandica. Donovan, Br. Sh. t. 77.—Montagu, Test. Br. p. 114. Dublin Bay, and Bray; plentiful.

8. ovata. Linn. Tr. 8. p. 85. t. 2. f. 4.—Montagu, Test. Br. p. 120. Dublin Bay, Portmarnock, and Lough Strangford.

8. tigerina. Linn. Tr. 8. p. 86. t. 2. f. 5.—Montagu, Test.

Br. p. 119. t. 1. f. 14. Rings-End. Dublin Bay; rare.

9. undata. Donovan, Br. Sh. t. 121.—Montagu, Test. Br. p. 118. Dublin Bay, plentiful; and of a large size in Belfast Lough. A rare British shell.

10. exoleta. Linn. Tr. 8. t. 3. f. 1.—Donovan, Br. Sh. t. 42. f. 1. Dublin Bay, and Portmarnock, of a large size, and several varieties.

11. decussata. Linn. Tr. 8. p. 88. t. 2. f. 6.—Donovan, Br. Sh. t. 67. Thousands of this shell are to be found on the shores in the neighbourhood of Dublin, and of a very large size: they must live in very deep water, and at a great distance from the shore, as I never found a pair of valves united.

12. Pullastra. Linn. Tr. 8. p. 88. t. 2. f. 7.—Montagu, Test. Br. p. 125. Dublin Bay, and Portmarnock; plentiful.

13. perforans. Montagu, Test. Br. p. 127. t. 3. f. 6.—Linn. Tr. 8. p. 89. Portmarnock; and in stones at Howth.

14. virginea. Linn. Tr. 8. p. 89. t. 2. f. 8.—Montagu, Test. Br. p. 129. Dredged at Bray, rare; and at Portmarnock, not uncommon.

15. aurea. Linn. Tr. 8. p. 90. t. 2. f. 9.—Montagu, Test. Br. p. 129. Dublin Bay, and Portmarnock, by Dr Turton. Bantry Bay by Dr Taylor; and in Carrickfergus Bay by Dr Macdonnell; rare.

16. sinuosa. Donovan, Br. Sh. t. 42. f. 2.—Pennant, Brit. Zool. 4. t. 55. f. 51. A. Dublin Bay; rare.

CHAMA.

Cor? Donovan, Brit. Sh. t. 134.—Wernerian Memoirs, i. t. 8. f. 7. One valve of this very rare shell was found in Dublin Bay by James Tardy, Esq.; and

there is a complete shell in the cabinet of Dr Blake of William Street, Dublin, who received it from Mr Green, fishmonger: it was given to him by a fisherman who dredged it in Dublin Bay. My friend Mr O'Kelly, informed me he made inquiry concerning this shell at the fishermen, who assured him they got five or six specimens before, but threw them away, thinking them of no use. I am thus particular, because I have great doubts of Chama cor being an inhabitant of the seas around Great Britain, or its neighbouring islands.

ARCA.

1. minuta. Donovan, Brit. Sh. t. 78. A. caudata.—Linn. Tr. 8. p. 92. One valve in Dublin Bay.

2. Glycymeris. Linn. Tr. 8. p. 93. t. 3. f. 3. One valve of this rare shell was found by Mrs Clewlow at Springvale; and several odd valves at Carrickfergus by Dr Macgee.

3. pilosa. Linn. Tr. 8. p. 94. t. 3. f. 4.—Donovan, Br. Sh. t. 37. A. glycimeris. One specimen at Portrahan Donnabate, by M. J. O'Kelly, Esq.

4. Nucleus. Donovan, Br. Sh. t. 63.—Linn. Tr. 8. p. 95. Dublin Bay and Portmarnock; plentiful.

5. barbata. (Plate xxiv. fig. 3.) Lister's General Conch. t. 231.—Rumphius, Mus. t. 44.—Linn. Syst. Nat. 2. p. 1140. "Shell oblong striate, bearded with byssus: beaks approximate; margin closed. Shell pale chesnut under the byssus, sometimes mixed with white, and marked with decussate striæ: the fibres in the angle of the section are nodulous."—Turton's Linné, 4. p. 250.

With an oblong-ovate, strong, white shell, very finely reticulated, and covered with an oliva-

ceous-brown epidermis: from the *umbo* to the margin diverge a number of almost equidistant flat ridges, covered with very fine, short, and thick set brown hair: all round the margin, it is beset with a byssus of rather long and strong hair: in the hollows at the anterior and posterior slopes, it is thickly covered with bristles of a dark umber colour: teeth of the hinge, at the umbo, rather small; but they increase in size as they diverge outwards, and oblique in opposite directions. The inside is moderately glossy, growing dimmer as it approaches the cavity of the shell: the margin is finely crenulated; and the whole inside has very pale glossy rays, and clouded with a pale chestnut colour.

This very perfect, and new shell on our coasts, was found alive, adhering to an oyster, from Killinchy in Lough Strangford, by Dr Macgee, Belfast.

OSTREA.

1. maxima. Donovan, Br. Sh. t. 49.—Montagu, Test. Br. p. 143. Portmarnock, rare; more plentiful at Bray; and common in Lough Strangford.

2. varia. Donovan, Br. Sh. t. 1. f. 1.—Montagu, Test. Br. p. 146. Portmarnock, not uncommon. Very fine and perfect specimens are common on the Lough Strangford oysters.

3. opercularis. Donovan, Br. Sh. t. 12. Pecten subrufus.—Montagu, Test. Br. p. 145. Dublin Bay, and Portmarnock; common.

4. lineata. Donovan, Brit. Sh. t. 116.—Montagu, Test. Br. p. 147. Dredged at Bray.

5. sinuosa. Donovan, Brit, Shells, t. 34. Pecten pusio.—Montagu, Test. Brit. p. 148. Pecten distortus. Portmarnock, rare; in Lough Strangford not uncommon.

6. obsoleta. Donovan, Brit. Sh. t. 1. f. 2.—Montagu, Test. Brit. p. 147. Portmarnock, rare. A very beautiful and perfect specimen was taken by the dredge at Bray,

7. edulis. Pennant, Brit. Zool. 4. t. 62. f. 70. inferior. Carlingford, Lough Strangford, and Carrickfergus.

ANOMIA.

1. Ephippium. Donovan, Brit. Sh. t. 26.—Montagu, Test. Br. p. 155. Dublin Bay, two specimens; and in great plenty on oysters from Carlingford and Lough Stranford.

2. Squamula. Pulteney in Hutch. Dorsat. p. 37. t. 13. f. 4.—Montagu, Test. Brit. p 156. & p. 561. Not uncommon, adhering to Carlinford oysters.

3. aculeata. Montagu, Test. Br. p. 157. t. 4. f. 5. Linn. Tr. 8. p. 103. In sand from Portmarnock; not uncommon.

4. undulata. Montagu, Test. Br. p. 153. 157. & 580. t. 4. f. 6.—Donovan, Br. Sh. t. 45. Ostrea striata. Callina Bay, and Rathgarmont, Lough Strangford.

5. pellucida. Shell orbicular, slightly wrinkled, thin, pellucid and of a bright amber colour; umbo small and margined, below which is a chalky-like spot, of a roundish shape; under valve flat, upper valve very convex. Diameter about an inch.

I first discovered this new shell on Color Coats Sands, near Tynemouth, Northumberland, Portmarnock, and Dublin Bay; rare.

MYTILUS.

1. rugosus. Donovan, Brit. Sh. t. 141.—Montagu, Test. Br. p. 164. Portmarnock; not uncommon.

2. edulis. Donovan, Br. Sh. t. 128.—Montagu, Test. Br. p. 159. Common on all the shores.

3. incurvatus. Linn. Tr. viii. p. 106. t. 3. f. 7.—Montagu, Test. Br. p. 159. Dublin Bay; rare.

4. pellucidus. Donovan, Br. Sh. t. 81.—Montagu, Test. Br. p. 160. Dublin Bay, and Portmarnock; rare.

5. Modiolus. Donovan, Br. Sh. t. 23.—Montagu, Test. Br. p. 163. Dublin Bay, and Donaghadee; plentiful.

6. umbilicatus. Donovan, Br. Sh. t. 40.—Montagu, Test. Br. p. 164. Dublin Bay; rare.

7. cygneus. Lough Fanla, King's County, and in the Grand Canal, about twenty miles from Dublin; very plentiful. Linn. Tr. viii. p. 109. t. 3. f. 2. & 3.—Montagu, Test. Br. p. 179.

8. anatinus. Linn. Tr. viii. t. 3. f. 1. & 4.—Montagu, Test. Br. p. 171. In the Shannon, at its junction with the Bresna, and in the Pond of the Botanic Garden at Glasniven, near Dublin.

9. discors. Linn. Tr. viii. p. 111. t. 3. f. 8. & 9. Portmarnock and Dublin Bay; rare. Plentiful in Lough Strangford.

10. fuscus. Shell oblong, narrow, with very fine transverse striæ: one side emarginate, the other rounded: beaks prominent, curved. Shell minute and brown. Turton's Linné, iv. p. 297. Lister's Conchology, t. 359. f. 197. This is a new shell in the British seas. It was found at Sligo, and is in the cabinet of Dr Macdonnell, Belfast.

PINNA.

1. ingens. Donovan, Br. Sh. t. 152. P. lævis, Linn. Tr. viii. p. 112.; a very fine specimen was found at Portrush, county of Antrim, by Mrs Clewlow of Belfast.

Order III.
UNIVALVE SHELLS.

NAUTILUS.

1. crispus. Montagu, Test. Br. p. 187. Supp. t. 18. f. 5. In sand from Portmarnock; not uncommon.

2. Beccarii. Montagu, Test. Br. p. 186. Supp. t. 18. f. 4. In sand from Portmarnock.

CYPRÆA.

1. Pediculus. Donovan, Br. Sh. t. 43.—Montagu, Test. Br. p. 201. Cy. arctica. Dublin Bay; rare. Portmarnock; not uncommon.

BULLA.

1. aperta. Donovan, Br. Sh. t. 120. f. 1.—Montagu, Test. Br. p. 206. Dublin Bay; rare.

2. ligniaria. Donovan, Br. Sh. t. 27.—Montagu, Test. Br. p. 205. Dublin Bay, and Portmarnock: not uncommon.

3. Akera. Donovan, Br. Sh. t. 79. B. resiliens. Amongst sea-weed at high-water mark at Warren Point, in vast numbers.

4. fontinalis. Linn. Tr. viii. p. 126. t. 4. f. 3.—Montagu, Test. Br. p. 226. In ditches at Clonooney, Banagher, and Naas, and in the Botanic Garden Pond at Glasniven.

5. Hypnorum. Linn. Tr. viii. p. 127. t. 4. f. 3.—Montagu, Test. Br. p. 228. In ditches at Clonooney and Naas; not uncommon.

6. cylindracea. Donovan, Br. Sh. t. 120. f. 2.—Montagu, Test. Br. p. 221. t. 7. f. 2. Portmarnock; rare.

7. obtusa. Montagu, Test. Br. p. 223. t. 7. f. 3.—Linn. Tr. viii. p. 128.—In sand from Portmarnock; not uncommon.

VOLUTA.

1. tornatilis. Donovan, Br. Sh. t. 57.—Montagu, Test. Br. p. 231. Portmarnock.

2. denticulata. Montagu, Test. Br. p. 234.—Supp. t. 20. f. 5. —Donovan, Br. Sh. t. 138. Vol. triplicata. Several specimens in Dublin Bay.

3. alba. Walker's Test. Min. Rar. f. 61.—Montagu, Test. Br. p. 225. Dublin Bay.

BUCCINUM.

1. hepaticum. Montagu, Test. Br. p. 243. t. 8. f. 1.—Linn. Tr. viii. p. 135. Lough Strangford; rare.

2. Lapillus. Donovan, Br. Sh. t. 11.—Montagu, Test. Br. p. 239.; common on every shore.

3. undatum. Donovan, Br. Sh. t. 104.—Montagu, Test Br. p. 237. Portmarnock and Dublin Bay.

4. reticulatum. Donovan, Br. Sh. t. 76.—Montagu, Test. Br. p. 240.; very plentiful at Portmarnock.

5. Macula. Linn. Tr. viii. p. 138. t. 4. f. 4.—Montagu, Test. Br. p. 241. t. 8. f. 4. B. Portmarnock and Dublin Bay.

STROMBUS.

1. Pes Pelecani. Donovan, Br. Sh. t. 4.—Montagu, Test. Br. p. 253. Portmarnock and Dublin Bay; plentiful.

MUREX.

1. Erinaceus. Donovan, Br. Sh. t. 35.—Montagu, Test. Br. p. 259. Portmarnock; common. Dublin Bay; rare.

2. gracilis. Donovan, Br. Sh. t. 169. f. 2. M. emarginatus. —Montagu, Test. Br. p. 267. t. 15. f. 5. & p. 586. Two specimens at the Pigeon-house.

3. Nebula. Linn. Tr. viii. p. 143.—Montagu, Test. Br. p. 267. t. 15. f. 6. Portmarnock, and Dublin Bay; rare.

4. costatus. Donovan, Br. Sh. t. 91.—Montagu, Test. Br. p. 265. Dublin Bay, and Portmarnock; rare.

5. septangularis. Montagu, Test. Br. p. 268. t. 9. f. 5.—Donovan, Br. Sh. t. 179. f. 4. Dublin Bay; scarce.

6. Turricula. Montagu, Test. Br. p. 262. t. 9. f. 1.—Donovan, Br. Sh. t. 156. M. angulatus. Portmarnock; rare.

7. rufus. Montagu, Test. Br. p. 263. In sand from Portmarnock; rare.

8. antiquus. Donovan, Br. Sh. t. 31. M. despectus.—Montagu, Test. Br. p. 256. M. despectus.—Linn. Tr. viii. p. 146. Portmarnock, and Dublin Bay; plentiful.

9. corneus. Montagu, Test. Br. p. 258.—Donovan, Br. Sh. t. 38. Dublin Bay, and Portmarnock; plentiful.

10. purpureus. Montagu, Test. Br. p. 260. t. 9. f. 3. In sand from Portmarnock.

11. muricatus. Montagu, Test. Br. p. 262. t. 9. f. 2. In sand from Portmarnock.

12. reticulatus. Montagu, Test. Br. p. 272.—Dacosta, Br. Con. p. 117. t. 8. f. 13. Strombiformis reticulatus. Not uncommon on the western coast, and at Carrickfergus.

TROCHUS.

1. Magus. Donovan, Br. Sh. t. 8. f. 1.—Montagu, Test. Br. p. 283. Portmarnock, rare; not uncommon in Donaghadee.

2. cinereus. Donovan, Br. Sh. t. 155. f. 2.—Montagu, Test. Br. p. 289. Dublin Bay, very rare.

3. lineatus. Donovan, Br. Sh. t. 74. large and two smaller figures.—Montagu, Test. Br. p. 284. T. cinerarius. Dublin Bay, Portmarnock, and Balbrigging; very common.

4. umbilicatus. Montagu, Test. Br. p. 286.—Donovan, Br. Sh. t. 74. fig. med. Portmarnock, Dublin Bay, and Killough, common.

5. tumidus. Montagu, Test. Br. p. 280. t. 10. f. 4. Portmarnock, and Dublin Bay, of a large size.

6. crassus. Donovan, Br. Sh. t. 71.—Montagu, Test. Br. p. 281. Dublin Bay, one specimen; plentiful on the rocks at Limerick; and not uncommon on the rocks at Killough.

7. papillosus. Donovan, Br. Sh. t. 127.—Montagu, Test. Br. p. 275. t. 10. f. 3. Tr. tenuis. One specimen in Dublin Bay; and fine specimens have been taken by the dredge at Bray, by Mr Nuttal.

8. Zizyphinus. Donovan, Br. Sh. t. 52.—Montagu, Test. Br. p. 274. Dublin Bay, and Portmarnock; plentiful.

9. discrepans. Plate xxiv. fig. 4. Shell conic, terminating in rather an obtuse point, with seven rounded volutions, well defined by a hollow, broad, and deep division: from the lip to the apex runs a deep concave groove; the whole shell is wrought with indistinct spiral ridges. In other respects, this shell agrees with the Trochus zizyphinus, and is probably only an ac-

cidental variety of that shell. In comparing it with specimens of the zizyphinus of the same size, I find it is shorter in proportion to the breadth of the *base;* and the *apex* is considerably blunter. Length, six-eighths of an inch; breadth, seven-eighths.

One specimen of this shell was found at Holywood, in Belfast Lough, by Miss Templeton of Belfast, who kindly favoured me with it to draw from.

10. rugosus. Plate xxiv. fig. 5. Shell subovate, milk-white, rather opaque, with four moderately raised whorls, which are well defined by the separating line: from the aperture to the apex, there is a pretty deep groove, which runs spirally very close to the suture of the spire: the body whorl is somewhat inflated, on the base of which there are three distinct spiral lines, which rise in the edge of the outer lip, and terminate where the lip is attached to the columella. The whole shell is covered with strong undulated striæ: on the under part they commence in the umbilicus (which is pretty large and deep), and diverge towards the sides; in the upper part of the shell, they in the same manner seem to diverge from the apex. Aperture suborbicular, and not much depressed; inner lip rather strong, and very slightly reflected near the umbilicus.

Found in drifted sand at Portmarnock by Dr Turton, who says it is not uncommon. Size of the shell scarcely an eighth of an inch.

11. erythroleucos. Donovan, Br. Sh. t. 155. f. 1. Tr. conicus.—Montagu, Test. Br. p. 278. Tr. striatus. Rings-end, Dublin Bay, by Dr Turton; rare.

TURBO.

1. littoreus. Donovan, Br. Sh. t. 33. f. 1, 2.—Linn. Tr. viii. p. 158. t. 4. f. 8, 9, 10, 11. common on all the shores.

2. rudis. Donovan, Brit. Sh. t. 33. f. 3.—Linn. Tr. viii. t. 4. f. 12, 13. Common on most shores.

3. crassior. Montagu, Test. Br. p 309. Supp. t. 20. f. 1. Donovan, Br. Sh. t. 178. f. 4. T. pallidus. Dublin Bay, by Dr Turton.

4. Ziczac. Montagu, Test. Br. Supp. p. 125.—Linn. Tr. viii. p. 160. t. 8. f. 14. In sand from Portmarnock; and in Lough Strangford.

5. Cimex. Montagu, Test. Brit. p. 315.—Donovan, Br. Sh. t. 2. f. 1. Portmarnock, among loose stones and sand at high-water mark.

6. Pullus. Donovan, Br. Sh. t. 2. f. 2.–6.—Montagu, Test. Br. p. 319. In sand at high-water mark, Portmarnock.

7. Ulvæ. Linn. Tr. viii. p. 164.—Montagu, Test. Br. p. 318. Very plentiful at high-water mark, Portmarnock.

8. sub-umbilicatus. Linn. Tr. viii. p. 165.—Montagu, Test. B . p. 316. Portmarnock, in sand rather scarce.

9. Cingillus. Montagu, Test. Br. p. 328. t. 12. f. 7.—Donovan, Br. Sh. t. 178. f. 1. T. vittatus. Portmarnock, by Dr Turton; rare.

10. graphicus. Plate xxiv. fig. 6. "Shell conic, pellucid light horn-colour, with moderately rounded spires, and generally two pale yellowish bands on the lower one, finely and regularly striate throughout, in a spiral direction: apex pointed: aperture sub-oval, with a thin even margin, not turned back on the pillar. It differs from the *Turbo insculptus*, in its colour, and pointed apex, and in having no duplicature

or sub-umbilicus on the pillar lip, and being without the small tooth. Length a line and a half; breadth not a line.

"Found in Dublin Bay, at the South Bull, and is in the cabinet of Dr Turton.

"A variety we found more conic and paler, with yellowish marks on the body whorl, which is larger in proportion to the rest, and all are more rounded and deeper defined."—*Dr Turton.*

11. interruptus. Montagu, Test. Br. Supp. p. 126. t. 20. f. 8.—Linn. Tr. viii. p. 166. In sand from Portmarnock; not uncommon.

12. vinetus. Montagu, Test. Br. p. 307.; Supp. t. 20. f. 7. Rings-End, Dublin Bay, by Dr Turton.

13. quadrifasciatus. Montagu, Test. Br. p. 328.; Supp. t. 20. f. 7. In sand from Portmarnock; rare.

14. elegans. Donovan, Br, Sh. t. 59. T. striatus.—Montagu, Test. Brit. p. 342.: Supp. t. 22. f. 7. Portrush, in the cabinet of Dr Macdonnell, Belfast.

15. fontinalis. Montagu, Test. Br. p. 348.; Supp. t. 22. f. 4. Common in almost all ditches, and in the Grand and Royal Canals.

16. Nautileus. Montagu. Test. Br. p. 464. H. nautileus; Supp. t. 25. f. 5.—Linn. Tr. viii. p. 169. t. 5. f. 4. Two specimens in a ditch at Naas.

17. cristatus. Montagu, Test. Br. p. 460. vignette 1. f. 7, 8. H. cristata. Plentiful near Naas; and in several ditches at Clonooney, King's County.

18. Clathrus. Donovan, Br. Sh. t. 28.—Montagu, Test. Br. p. 296.—Linn. Tr. viii. p. 171. t. 5. f. 1. Dublin Bay, and Portmarnock, rather plentiful, and of both varieties of the shell.

19. pentangularis. Plate xxiv. fig. 7. Shell with eight whorls, abruptly tapering to a point, and terminating

in a sharpened apex. The first, or body whorl, is completely detached from the other volutions. It has two very elevated spiral ribs, running from the base to the apex, at the base and centre of the whorls, the lower one giving a strong division to the spires; the whorls are strongly wrinkled longitudinally; aperture perfectly round. Colour of a deep chestnut. When viewed from the base, the detached or body volution gives it the appearance of being deeply umbilicated. Length, ½ inch; breadth ¼.

One specimen of this new shell was found in Dublin Bay by Dr Turton.

20. nitidissimus. Montagu, Test. Br. p. 299. t. 12. f. 1.—Linn. Tr. viii. p. 175. Portmarnock, rare.

21. Terebra. Montagu, Test. Brit. p. 293.—Donovan, Br. Sh. t. 22. f. 2. Dublin Bay, Portmarnock, and Killough; common.

22. nigricans. Donovan, Br. Sh. t. 72. T. perversus.—Montagu, Test. Br. p. 357. t. 11. f. 7. T. bidens. On a mossy stone at Clonooney; in old walls at Ferbane; and near Downpatrick.

23. Muscorum. Donovan, Brit. Sh. t. 80.—Montagu, Test. Br. p. 335.; Supp. t. 22. f. 3. In the crevices of a large mossy stone, Clonooney; in an old wall near Ferbane; and in the sand-banks at Portmarnock Burrow, very plentiful.

HELIX.

1. Lapicida. Montagu, Test. Br. p. 435.—Donovan, Brit. Sh. t. 39. f. 2. In the neighbourhood of Belfast by Dr Macdonnell.

2. Planorbis. Linn. Trans. viii. p. 188. t. 5. f. 13.—Montagu, Test. Brit. p. 450. H. complanata; Supp.

t. 25. f. 4. In ditches at Clonooney, plentiful, and of a large size; in several ditches near Naas; and in the Canal.

3. planata. Linn. Tr. viii. p. 189. t. 5. f. 14.—Montagu, Test. Br. p. 450.; Supp. t. 25. f. 1. H. carinata, In a ditch at Clonooney, rare; not unfrequent in a ditch at Naas.

4. Vortex. Montagu, Test. Br. p. 454.; Supp. t. 25. f. 3.—Donovan, Br. Sh. t. 75. In a stream on the bog near Clonooney; in a ditch at Shannon Harbour; at Ferbane, Naas and Downpatrick, plentiful.

5. cornea. Donovan, Br. Sh. t. 39. f. 1.—Montagu, Test. Br. p. 448. In a ditch at Maynooth, near the Royal Canal, not uncommon.

6. Spirorbis. Montagu, Test. Br. p. 459.; Supp. t. 25. f. 2. —Linn. Tr. viii. p. 191. In a ditch at Sallins, near Naas.

7. contorta. Donovan, Br. Sh. t. 99.—Montagu, Test. Br. p. 457.; Supp. t. 25. f. 6. Not uncommon in ditches at Clonooney, Naas, and Ferbane, and of a large size.

8. alba. Linn. Tr. viii. p. 192.—Montagu, Test. Br. p. 459; Supp. t. 25. f. 7. In ditches with the above; and in the Canal; rare.

9. fontana. Montagu, Test. Br. p. 462. t. [illegible]. f. 6.—Linn. Tr. viii. p. 193. In a ditch at Ferbane, rare.

10. paludosa. Linn. Tr. viii. p. 193. t. 5. f. 5.—Montagu, Test. Br. p. 440. Plentiful in the sand at Portmarnock Burrow.

11. Ericeto-rum. Montagu, Test. Br. p. 437.; Supp. t. 24. f. 2. Donovan, Br. Sh. t. 151. f. 2. This shell abounds in all dry places in Ireland.

[illegible] virgata. Donovan, Br. Sh. t. 6[illegible]. H. zonaria.—Montagu, Test. Br. p. 415.; Supp. t. 24. f. 1. Common in most dry situations.

13. rufescens. Montagu, Test. Br. p. 420.; Supp. t. 23. f. 2. —Donovan, Br. Sh. t. 157. Common in dry places.

14. nitens. Linn. Tr. viii. p. 198 t. 5. f. 7.—Montagu, Test. Br. p. 425. H. lucida; Supp. t. 23. f. 4. Under stones at Naas, Clonooney, and Downpatrick.

15. hispida. Montagu, Test. Br. p. 423.; Supp. t. 23. f. 3.—Donovan, Br Sh. t. 151. In a field near Dublin; at Naas and Downpatrick.

16. radiata. Montagu, Test. Br. p. 432.; Sup. t. 24. f. 3.—Linn. Trans. viii. p. 199. At Portarlington, Enniscorthy, Clantarf, Naas, and Downpatrick.

17. umbilicata. Montagu, Test. Br. p. 434. t. 13. f. 2.—Linn. Tr. viii. p. 200. In the crevices of a mossy stone at Clonooney Barracks.

18. elliptica. Plate xxiv. fig. 8. Shell imperforate, sub-umbilicated, sub-depressed, and nearly elliptic: *aperture* sub-oval; whorls three, and scarcely elevated above the body of the shell: colour yellowish, very pellucid, and glabrous. Size of the shell 1½ eighth of an inch. I found one specimen of this new shell in moss, on the stump of an old tree, at the Gate of Gullan, Ferbane, King's County; and one specimen under a stone on a mud-wall at Downpatrick.

19. Arbustorum. Donovan, Brit. Shells, t. 136.—Montagu, Test. Br. p. 413. In a field near Dublin.

20. janthina. "Testa sub-imperforata, sub-rotunda, obtusa diaphana, fragilissima, apertura postice dilatata, labro emarginato. Animalculum vivum madet sanie violacea, manus altrectantis inficiente."

Habitat in Europa, Asia, Africa; in M. Mediterraneo *frequentior; etiam pelagica.*—Linn. Syst. Nat. ii. p. 1246. No. 689.—Turton's Linné, iv. p. 528.

Shell nearly imperforated, roundish, obtuse, diaphanous, and very brittle; aperture dilated behind, with an emarginate lip. The colour of the shell is violet, with a sub-triangular aperture: the animal, when alive, shines by night, and stains the hand with a violet or purple dye.

Many hundreds of this shell were found at Portrush, county of Antrim, by Mrs Clewlow of Belfast, and Miss Kelly, after a storm, with the animal alive in them. Some of them were found floating on the surface of the water, and they seemed to be buoyed up by a little reticulated membrane, of a purple colour; there also exuded from the body of the animal a fine purple mucous substance. This shell is well known as a West India species, and we can only suppose they have been carried on the surface of the water, during a long continuance of westerly winds, which prevailed at the time, as they have never since been met with.

The account given by Mrs Clewlow to me of this shell, agrees in a great measure with the description given by *Brown*, in his *Account of Jamaica*, which I shall here quote: "*Purple Ocean Shell.* The creature which forms and inhabits this shell, is a native of the ocean, and lives frequently many hundred leagues from any land; but having met with many of the kind between *Bermudas* and the Western Islands, in my voyage from *Jamaica*, it

enables me to communicate the following account of them.

"The creature probably passes the greatest part of life at the bottom of the sea, but rises sometimes to the surface, and to do so, it is obliged, *piscium more,* to distend an air-bladder, which, however, is formed only for the present occasion, and made of tough viscid slime, swelled into a vesicular transparent mass, that sticks to the head of the animal, at the opening of the shell. This raises and sustains it while it pleases to continue on the surface; but when it wants to return, it throws off its bladder, and sinks. I have taken up many of these insects alive, with the bladder yet affixed to the aperture of the shell, and still preserve some with it on, in spirits. I have also observed many of the vesicula themselves swimming upon the surface of the water about that place, which induced me to think they were thrown off as the creature retired. It is observable, that on touching the body of this insect, it diffuses a beautiful purple liquor, of which colour the shell generally appears when fresh."—*Brown's Jamaica,* p. 400.

21. vivipara. Donovan, Br. Sh. t. 87.—Montagu, Test. Br. p. 386. In a stream at Newton Ardes, county of Down; rare.

22. nemoralis. Donovan, Brit. Sh. t. 13.—Montagu, Test. Br. p. 411, 412. H. hortensis. Common on every road side, and in all its varieties.

23. hortensis. Montagu, Test. Br. p. 407. H. aspersa.—Donovan, Br. Sh. t. 131. Common in every hedge and garden.

24. elegans. Plate xxiv. fig. 9. Shell sub-pellucid, somewhat glossy, with seven ventricose and very deeply divided volutions, tapering to rather an obtuse apex: the first, or body whorl, is much inflated: a white band runs spirally from the base to the apex, giving it a strong appearance of being carinated, and the volutions are slightly wrinkled across: It is furnished with a deep and wide umbilicus, which viewed directly from the *base*, is partly hid by the reflected lip of the shell: *aperture* subrotund, lip very thin, and reflected on the columella. The colour is of a dirty white, with several interrupted dark umber-coloured bands, which run spirally from the base to the apex. Length, $\frac{6}{8}$ths of an inch; breadth, $3\frac{1}{2}$ eighths.

One specimen of this very elegant shell, was found in a field beyond Kilmainham Jail, near the turnpike of Golden Bridge, Dublin, by Mr Edward Stephens, and is now in the cabinet of M. J. O'Kelly, Esq. who kindly favoured me with it to describe and draw from.

There is a shell in Turton's Linné, vol. iv. p. 524. which bears the name of Helix elegans; but the learned authors of the Catalogue of the Brit. Test. in the 8th vol. of the Linn. Trans. have superseded that name, by calling the shell Dr Turton refers to in Lister's Conchology, tab. 61. fig. 58. Trochus terrestris. Under these circumstances, I may be justified in adopting this name, as no other could be more appropriate.

25. Cochlea. Plate xxiv. fig. 10. Shell of a dark horn colour, with seven tapering rounded volutions;

the three next the apex are twisted like a cork-screw, and terminate in a sharp point; the five lower whorls slope gradually to a carinated ridge, which commences in the centre of the outer margin of the lip, and loses itself in the fifth whorl, giving the volutions the appearance of being flat at bottom: the whorls are slightly wrinkled obliquely across; the lower whorl is considerably tumid. Aperture somewhat angulated, suboval, and a little depressed; lip very thin, and reflected on the columella at the base, with a deep and wide umbilicus.

Found by Mr Thomas Stephens in a pond in the College Botanic Garden, and is in the cabinet of Mr O'Kelly. Both this and the preceding were found in his presence.

26. elegantissima. Donovan, Br. Sh. t. 179. f. 1. Turbo acutus.—Montagu, Test. Br. p. 298. t. 10. f. 2. Tur. elegantissimus. In sand from Portmarnock; rare.

27. polita. Donovan, Brit. Shells, t. 177. Turbo albus.—Montagu, Test. Br. p. 398. Bantry Bay, rare.

28. bifasciata. Donovan, Br. Sh. t. 18. f. 1. T. fasciatus.—Montagu, Test. Br. 346. Supp. t. 22. f. 1. Very plentiful on the sand hills at Portmarnock Burrow.

29. Lackhamensis. Montagu, Test. Br. p. 394. t. 11. f. 3.—Linn. Trans. viii. p. 212.

30. obscura. Linn. Trans. viii. p. 212. t. 5. f. 11.—Montagu, Test. Br. p. 391.; Supp. t. 22. f. 5. One specimen on a dry mud wall near Clonooney.

31. lubrica. Montagu, Test. Br. p. 390.; Supp. t. 22 f. 6.—Linn. Tr. viii. p. 213. t. 5. f. 12. Under stones on the banks of the Bresna; near Fer-

bane; and on the sand hills at Portmarnock Burrow; common.

32. vitrea. Montagu, Test. Br. p. 321. t. 12. f. 3.—Linn. Trans. viii. p. 218. In sand from Portmarnock; rare.

33. arenaria. Montagu, Test. Br. p. 322. t. 12. f. 4. Tur. decussatus. In sand from Portmarnock; rare.

34. stagnalis. Donovan, Brit. Sh. t. 51. f. 2.—Montagu, Test. Br. p. 367. t. 16. f. 8. In a ditch and stream at Clonooney, two inches from the apex to the base: in several ditches at Naas; and in the Canal.

35. palustris. Linn. Tr. viii. p. 216. t. 5. f. 8.—Donovan, Br. Sh. t. 175. f. 1. H. fragilis & f. 2. H. fontinalis. In ditches at Clonooney, Naas, and Downpatrick; also in the Canal; plentiful.

36. fossaria. Linn. Trans. viii. p. 217. t. 5. f. 9.—Montagu, Test. Br. p. 372. t. 16. f. 9. In a ditch on the Bog of Clonooney; in the river Bresna; at Ferbane; and in a ditch near Downpatrick, on the Strangford road.

37. succinea. Montagu, Test. Br. p. 376. t. 16. f. 4. H. putris. Donovan, Brit. Sh. t. 168. f. 1. H. putris. In ditches at Clonooney, Naas, and Downpatrick; and fine specimens in the Canal.

38. putris. Montagu, Test. Br. p. 373. t. 16. f. 3. H. peregra. —Linn. Tr. viii. p. 219. Common in almost every ditch.

39. limosa. Plate xxiv. fig. 11. "Testa imperforata, oblongiuscula, pellucida, acuta, apertura ovata." —Linn. Syt. Nat. ii. p. 1249. No. 706.; Turton's Linné, iv. p. 539. Shell imperforate, somewhat oblong, pellucid, acute, with an ovate aperture. It inhabits wet meadows of Europe; and according to Dr Turton, is an indistinct species.

I have no opportunity of referring to the figures pointed out by the above authors in their synonyms; but the shell before me is very different from the *H. putris*, although at first sight it may be mistaken for it. It differs from that shell in being more oblong, the aperture narrower, the spire longer, and more tapering and acute, the volutions more prominent and rounded, and very deeply divided by the separating line, and in having one whorl more more than the *H. putris*. Colour of a reddish-brown. I found them plentiful in a ditch on the Bog of Allen, near Clonooney Barracks.

40. tentaculata. Donovan, Br. Sh. t. 93.—Montagu, Test. Br. p. 389. In a stream at Clonooney; in ditches at Naas; and in the Canal plentiful.

41. canalis. Montagu, Test. Br. p. 309. t. 12. f. 11. In sand from Portmarnock.

42. auricularia. Donovan, Brit. Sh. t. 51. f. 1.—Montagu, Test. Br. p. 275. t. 16. f. 2. and p. 381. t. 16. f. 1. H. limosa. In a ditch at Clonooney; and in the pond of the Botanic Garden, Dublin.

43. lævigata. Montagu, Test. Br. p. 382.—Donovan, Br. Sh. t. 105. Plentiful at high-water mark, Portmarnock.

NERITA.

1. Canrena. Donovan, Br. Sh. t. 167. N. intricata.—Montagu, Test. Br. Supp. p. 148. Portmarnock, one specimen.

2. glaucina. Donovan, Br. Sh. t. 20. f. 1.—Montagu, Test. Br. p. 469. Dublin Bay, Portmarnock, and Portrush, plentiful. I found one specimen in Dublin Bay, measuring 1¼ inch from the

base to the apex, being fully half an inch longer than any specimen hitherto found on the British coasts.

3. fluviatilis. Montagu, Test. Br. p. 470.—Donovan, Br. Sh. t. 16. f. 2. In a stream at Clonooney; in the Shannon and Bresna; and in some places of the Canal, adhering to stones.

4. littoralis. Linn. Trans. viii. p. 226. t. 5. f. 15. Common on most shores.

5. glabrissimus. Plate xxiv. fig. 12. N. with a pellucid, and almost globular shell, of a bluish-white colour, with four volutions, covered with rather wide striæ, which crosses the whorls obliquely: the whorls are pretty deeply divided, and somewhat inflated: the spire does not rise much above the body of the shell: aperture sub-lunated: umbilicus long and narrow, covered with fine regular longitudinal striæ: lip very thin, and slightly reflected on the base of the shell. Size of the shell one-eighth of an inch. Found by Dr Turton in Dublin Bay.

HALIOTIS.

1. tuberculata. Donovan, Br. Sh. t. 5.—Montagu, Test. Br. p. 473. One specimen was got by the dredge at Springfield, by Mr Templeton of Belfast, who assures me several specimens have been picked up on the shores of Down, particularly in the neighbourhood of Springfield.

PATELLA.

1. vulgata. Donovan, Br. Sh. t. 14.—Montagu, Test. Br. p. 475. Common on all rocky shores.

2. ungarica. Donovan, Br. Sh. t. 21. f. 1.—Montagu, Test. Br. p. 486.—Dublin Bay, and Portmarnock, rare; but not uncommon, and of a large size, adhering to oysters, &c. in Lough Strangford.

3. militaris. Donovan, Br. Sh. t. 171.—Montagu, Test. Br. p. 486. t. 13. f. 11. Dublin Bay, and Portmarnock.

4. lacustris. Montagu, Test. Br. p. 482. P. fluviatilis.—Donovan, Br. Sh. t. 147. In a mill-race, about a mile below Naas; plentiful.

5. oblonga. Montagu, Test. Br. p. 484. P. lacustris.—Donovan, Br. Sh. t. 150. Adhering to the water lily in a stream on the Bog of Allen, near Clonooney.

6. pellucida. Donovan, Br. Sh. t. 3. f. 1.—Montagu, Test. Br. p. 477. Portmarnock; rare.

7. cœrulea. Donovan, Br. Sh. t. 3. f. 1.—Montagu, Test. Br. p. 477.—Linn. Trans. viii. p. 234. P. pellucida, testæ seniores. Dublin Bay, and Portmarnock; rare.

8. virginea. Donovan, Br. Sh. t. 21. f. 2.—Montagu, Test. Br. p. 480. Portmarnock, and Dublin Bay, rare; not uncommon in Lough Strangford.

9. Fissura. Donovan, Br. Sh. t. 3. f. 2.—Montagu, Test. Br. p. 490. Portmarnock; rare.

10. Græca. Donovan, Br. Sh. t. 21. f. 3. P. reticulata.—Linn. Tr. viii. p. 236.—Montagu, Test. Br. p. 492. P. reticulata. Portmarnock, rare; not uncommon in Lough Strangford.

DENTALIUM.

1. entalis. Donovan, Br. Sh. t. 48.—Montagu, Test. Br. p. 494. Portmarnock, and Dublin Bay; rare.

Turbo Bryereus. Montagu, Test. Brit. p. 313. t. 15. f. 8. —Donovan, Brit. Sh. t. 178. f. 3. T. costatus. One specimen at Portmarnock.

Helix caperata. Montagu, Test. Brit. p. 430. t. 11. f. 11.—Linn. Tr. viii. p. 196.; not uncommon at Naas, on mud walls.

Helix janthina. Bantry Bay. Lehinch, county of Clare, and Dunmore, Waterford, by Samuel Wright, Esq. It would appear from this shell having been found on the east coast of Ireland, and in different places, that it is actually an inhabitant of our seas. But it is somewhat singular, it should have been so long of being discovered by conchologists.

XXXI. *Remarks respecting the Causes of Organization.*

By Dr Barclay.

(Read 28th December 1815.*)*

I have been led to the following observations, from perusing a description of a *monstrous fœtus*, by the late Dr Sandifort, Professor of Physic, Anatomy, and Surgery, in the University of Leyden*. The fœtus he describes, is in many respects similar to one in my own collection, and which was sent to me some years ago by a friend

* This description consists of eighty-six pages in quarto, and is accompanied with several engravings. It was published at Leyden in the year 1784, and has for its title, "*Anatome Infantis cerebri destituti.*"

in the country. It wants all the bones of the cranium, excepting the bones and the parts of bones which enter into the formation of the base. On this base, there rests a soft substance, divided into similar halves between right and left, but exhibiting no character of a brain, in its form, magnitude, colour, or structure, only that the nerves, which are regular in appearance, and which pass through the usual foramina of the cranium, are all connected with it.

The object of the Doctor, is to explain how this and other similar productions could have possibly been formed without a brain; and in making the attempt, he inclines to adopt the opinion of Haller, that at one time the several processes of organization had been going on in the usual manner, when, interrupted by some accident, a disease had been induced, which occasioned the destruction of the parts that are wanting.

In corroboration of this opinion, he informs us, that some of the mothers of such children, had distinctly recollected particular injuries which they had received during their pregnancy; and that in cases where such were born at a twin-birth, the other child was frequently complete in all its parts. He adds, too, that it would be otherwise difficult to conceive, how the nerves issuing through the base of the cranium, and supposed by him to originate in the brain, could exhibit the healthy and natural appearance, or how the

bloodvessels approaching the base should have exactly the usual characters of those that are destined to nourish a regularly proportioned organ.

But though such an hypothesis may illustrate the case of which he is treating, it will not explain how the other fetuses to which he alludes, are formed, without the head,—some without the head and the neck,—some without the head, the neck, and the shoulders,—and some without the abdominal viscera. It is not insinuated, nor is it believed, that the parts wanting in these fetuses had ever existed; and it is therefore admitted, that a great number of the organs may be formed without the aid or co-operation of those that are considered as of principal importance.

Hence, the hypothesis, that growth and vitality in all circumstances, are necessarily dependent on the action of these organs, is proved to be false, and to be founded, like many other physiological deductions, on what Bacon calls *Experientia vulgaris*,—a kind of experience that but rarely leads to certain conclusions.

It is true, that in most animals, if the head, the brain, or abdominal viscera were to be removed, the consequence would be the immediate death of all the other parts. Nay, from the connection, the mutual dependence, and the powerful sympathy occasionally subsisting among the different parts of the system, it is even true, that a slight injury inflicted on parts which usually are con-

sidered as of trifling importance, has sometimes proved fatal to the whole structure. But from these facts, are we hastily to conclude with the vulgar, that the joint co-operation of all the organs, or the principal organs, is necessary to produce the phenomena of life? or are we to suppose, that because these phenomena are only perceived through the medium of organs, that these organs are essential to the existence of Life itself?

Organization, or those processes by which the organs themselves have been formed, connected and arranged, are among the most striking phenomena of life; and, therefore, the life, or a principle of life, must necessarily have existed, and even operated, before a single organ could be formed; it being impossible that the organs could precede, regulate, or be the cause of, those processes by which they themselves are brought into existence. The geologist, therefore, with reason infers, that all fossil, organized substances, of whatever order, genus or species, had once lived in a state of connection either with the animal or vegetable kingdom, being evidently the effects, and not the cause of the vital processes of organization.

Even Bichat and Richerand, and several more of the French Physiologists, sufficiently disposed to ascribe much to the *ponderable* materials of which organized systems are composed, and especially when assisted by what Sprengel calls the *Corpora imponderabilia*, as heat and light, the

electric, magnetic, and galvanic fluids, with the singular phenomena of their polarisations; are unable to explain how a plant or animal, that only furnish the materials of nourishment, can organize the systems of their offspring, or how, the materials being the same, can, by their chemical or mechanical properties, arrange themselves into such a diversity of varied, intricate, but regularly defined and specific structures, as are found in the animal and vegetable kingdoms. Even these Physiologists have been under the necessity of calling in the aid, of what they denominate *Vital Laws*,—laws that operate in conformity to the plan on which the species of the plant or animal is to be constructed, not according to the properties of the food and drink, or the air that is inspired by the individual. Unwilling, however, to invoke here the assistance of Deity, or to admit the operations of a vital principle, they are laws enacted by no Legislature, and enforced by no agent that has yet been named; but laws or regulations that are self-created, and which, when personified by the power of fancy, have, according to the courtesy of French Physiology, the powers and privileges of real substantial independent beings. Now, these laws being as inconceivable as those organs that construct themselves, the celebrated LEIBNITZ, BONNET, and BUFFON, not able to imagine how life could exist without a regularly organized structure, or how such struc-

tures could possibly be formed in the present times, when the Deity, as their hypothesis implies, no longer exerts either his creative or superintending powers, are inclined to believe, that all organized systems were created at once in some of the remotest periods of antiquity, and being endowed with a slight degree of perception or irritability, are ready to expand into maturity as soon as they meet with a proper nidus, suitable nourishment, and appropriate excitement. Till then, they are floating in countless myriads, through the elements of air, water, and earth, in the state of extremely minute and invisible atoms, which LEIBNITZ calls *monads*,—BONNET, *germs*,—and BUFFON, *organic particles* or *molecules*.

So far, these eminent Philosophers agree, though differing considerably when descending to detail, excepting that they all somewhat approach to a system of fatalism; and LEIBNITZ, the most, denying the existence of cause and effect, and substituting for them what he calls *harmony*,—a creature of his fancy, that does not seem to be very intelligible. None of them account for the production of hybrids or mules between different species. BONNET, who attempts it, is rather unsuccessful, and, on his principles, would be equally embarrassed in accounting for either excesses or deficiencies of organs in monsters.

Instead of soaring on the wings of fancy into these boundless regions of conjecture, would it

not be preferable, in such investigations, to take for our guides patient experiment and cautious observation? They may not carry us so far or so fast as many will in general be inclined to go; but, so far as they conduct us, they will do it on certain and on safe grounds. Inquiring at them, they give us no information whatever respecting any previous existence of plants or animals floating invisibly through the regions of space, in the state of infinitely minute organized atoms: They only inform us, that the first materials out of which organized structures are formed, are fluids secreted from the vessels of the parents, and that *something* operating within these fluids begins to arrange them into systems of organs similar to those belonging to the species of the individuals that supply the materials, and that this something, continuing to operate on the same plan, making always a selection of what is useful, and rejecting what is hurtful, arranges the materials that are afterwards supplied from the food and drink, and the air that is inspired, till the organs be completed: That the system of organs thus formed, is the medium of intercourse between it, and surrounding objects; so that they are found mutually to re-act upon one another: That in some animals, when powerfully excited, it employs a part of these organs to destroy the rest; and often, when the organs are deficient or injured, or in a state which it cannot re-

pair nor carry on its destined operations, it deserts them entirely, leaving them to the fate of their own inherent chemical affinities, which sooner or later dissolve the temporary arrangements of their particles, and mingle them again with the mass of dust from which they had been taken.

If the philosopher be anxious to know what is the nature of these Agents that thus organise the various structures of plants and animals, he can only know them from their Effects; and as these are different in different structures, he may safely conclude, that their orders, genera, and species, are as many as are the orders, genera and species of the structures which they form. Of their *real essence*, as of that of any other substance in nature, he must be content to remain ignorant. But should he wish merely to know them, as he knows other substances, from their *effects*, in that way he may know more of them than of any others that have ever happened to engage his attention. No substances produce such a number or such a variety of specific effects, or in such a regular order of succession as *they* do in constructing their systems; and, in acting through the medium of these systems, no substances exhibit such a number or such a diversity of specific operations; while the systems themselves, in each species, display additional discriminating characters, in their form, magnitude, and colours; in the number of their organs, in the varieties of their kinds, in

their relative situations, connections and proportions.

The wonder is, that these agents or active substances, possessed only of limited powers, and frequently re-acted upon by their organs, and through the medium of these organs, by external causes, can, amidst the diversities of climate and circumstance, and from such an immense variety of materials, as must often occur in the food and drink, be able to construct *regular* systems so frequently as they do.

In this view, a monstrous production should cease to be a matter of any surprise, as, weighing and deliberating on every circumstance, those which are termed *natural* productions, seem by much the greater wonder of the two. And when we consider how accurately preserved are the regular proportions between the sexes and accompanying instincts in sex and species, notwithstanding the powers bestowed upon many of regulating their temperature to a certain extent, we are tempted to suspect the superintendence, direction, and assistance of some *superior power* and *intelligence* that is not embarrassed by these differences of time or place, or the changes of circumstance in which they are produced.

At the same time, from observing that this power is not extended to unlimited degrees, and to fewer degrees with regard to individuals

than species, and with regard to species than to genera, there is reason to believe that it is rather limited from wisdom than from physical resistance; and hence are circumstances allowed to operate to the injury, mutilation, and the destruction of numerous individuals, while their species, notwithstanding, is regularly preserved; in other words, are permitted to operate only in proportion to the more or less abundant supply of the new individuals that are successively brought into existence for continuing the species.

XXXII. *On the Genera and Species of Eproboscideous Insects.*

By William Elford Leach, Esq.

(Read 10th April 1810.)

INSECTA EPROBOSCIDEA.

Character Essentialis.

Caput a trunco suturâ saltem discretum.
Haustellum valvulis duabus tectum aut supertectum.
Ungues compositi.

Character Naturalis.

"CORPUS * subovatum depressum: abdomen maximâ parte exceptâ cute coriaceâ solidiusculâ vestitum."

"Caput sæpè thorace angustius, suborbiculatum: *oculi* laterales subovales immersi distantes quandoque vix discernandi: *ocelli* in plurimis deficientes;" *antennæ* ante oculos

* *Characteres sic " " notatos observavit Cl. Latreille.*

los in clypeum vel ad clypei latera insertæ, brevissimæ nunc lamellæ dentiformes nunc tuberculiformes setigeræ: "*haustellum* e tuberculo enascens e setis duabus constans, at setam unicam cylindricam elongatam porrecto-arcuatam referens; setâ superiore subtus fornicatâ et inferam recipiente:" *valvulæ* duæ subcorneæ lamelliformes longitudinales elongatæ angustæ subæquè latæ pilosæ obtusæ ad margines internos conniventes haustellum tegentes aut supertegentes: *labium* membranaceum sæpius concavo-impressum.

"Truncus subtrapeziformis et anticè paulò angustior vel quadratus lineâ transversâ impressâ posticè sæpiùs notatus; margine antico in multis retrorsùm arcuato seu concavo et capitis marginem posticum excipiente; stigmata quatuor distincta, duobus ad angulos anticos, aliis posticis: *alæ, haltares* et squamulæ modo existantes modo deficientes: *alæ* horizontales subincumbentes aut divaricatæ: *pedes* breves crassi extensi, antici duo ab aliis remoti; tarsi omnes 5-articulati, articulo ultimo majore crasso; ungues duo validissimi quasi duplicati aut ternati, basi bidentati aut tridentati."

"Abdomen latum subtrigonum vel suborbiculatum distendendum supra ad basin transversè coriaceum, ultra molle spongiosum et infra saltem inarticulatum."

"LARVA in matris abdomine nutrienda ad transformationem excludenda."

"PUPA larvæ cute induratâ obtecta, ad unum apicem suborbiculatim impressa."

Stirpium

Stirpium Generumque Synopsis.

Stirps I.

Alæ duæ; cellulæ limbales tantùm inchoatæ. *Thorax* anticè acuminatus integer. (*Collum* distinctum.)

Genus 1. Hippobosca. *Ocelli* nulli.

Stirps II.

Alæ duæ; cellulæ limbales completæ. *Thorax* anticè arcuato-emarginatus capitis marginem posticum excipiens.

* *Alæ subæquè ferè latæ apice rotundatæ.*

Genus 2. Feronia. *Ocelli* nulli.

——— 3. Ornithomyia. *Ocelli* tres.

** *Alæ acuminatæ.*

——— 4. Stenepteryx. *Ocelli* tres.

——— 5. Oxypterum. *Ocelli* nulli.

Stirps III.

Alæ nullæ. *Thorax* anticè arcuato-emarginatus capitis marginem posticum excipiens.

Genus 6. Melophagus. *Ocelli* nulli.

Characteres Stirpium et Generum.

STIRPS I.

Caput trunco angustius; collum distinctum.
Alæ duæ cellulis limbalibus tantùm inchoatis.
Pectus anticè impressum non emarginatum.

Gen. 1.—HIPPOBOSCA.

HIPPOBOSCA, *Auctorum.*

Antennæ tuberculiformes in clypei fossulis receptæ; setâ dorsalî elongatâ.

Labium subtriangulare.

Haustellum cylindricum paululum incurvatum valvulis æquante.

Ocelli nulli.

Oculi valdè distincti ovati.

Tarsi ungue singulo valdè dentato: dente infero obtuso; basis infera etiam brevissima et obtusè producta.

Alæ subæquè ferè latæ, apice rotundatæ.

STIRPS II.

Caput trunco angustius margine postico in trunci emarginationem recepto.

Alæ duæ cellulis limbalibus completis.

Pectus anticè emarginatum.

Gen. 2.—FERONIA.

Antennæ tuberculiformes, hirsutæ in foveolis receptæ.

Labium breve semicirculare.

Haustellum cylindricum subincurvum valvulis paulò brevius.

Ocelli nulli.

Oculi valdè distincti ovati.

Tarsi unguibus bidentatis.

Alæ subæquè ferè latæ, apice rotundatæ.

Gen. 3.—ORNITHOMYIA.

ORNITHYMIA, *Latreille, Olivier.*
HIPPOBOSCA, *Auctorum.*

Antennæ lamelliformes hirsutæ in clypeum ante oculos insertæ.

Labium apice rotundatum, emarginatum aut rectum.

Haustellum breve aut elongatum.
Ocelli tres in foveolis verticis receptæ et in triangulum dispositi.
Oculi valdè distincti ovati.
Tarsi unguibus tridentatis.
Alæ subæquè ferè latæ, apice rotundatæ.

Gen. 4.—STENEPTERYX.

Ornithomyia, *Latreille, Olivier.*
Hippobosca, *Auctorum.*

Antennæ lamelliformes hirsutæ (divaricatæ.)
Labium apice arcuato-subrotundatum.
Haustellum valdè elongatum (valvulis longius.)
Ocelli tres in verticis foveolis receptæ et in triangulum dispositi.
Oculi valdè distincti ovati.
Tarsi unguibus tridentatis.
Alæ angustæ apice acutissimæ.

Gen. 5.—OXYPTERUM.

Oxypterum, *Kirby,* MSS.
Ornithomyia, *Olivier.*
Hippobosca, *Schæffer.*

Antennæ dentiformes hirsutæ ad clypei latera ante et inter oculos insertæ.
Labium subconcavum margine antico rotundato.
Haustellum valvulis æquale.
Ocelli nulli.
Oculi parvi ovati laterales.
Tarsi unguibus tridentatis.
Alæ acuminatæ.

STIRPS III.

Caput trunco paulò latius aut illius latitudine.
Alæ nullæ.
Pectus anticè emarginatum.

Gen. 6.—MELOPHAGUS.

MELOPHAGUS, *Latreille.*
HIPPOBOSCA, *Auctorum.*

Antennæ in fossulis receptæ.
Labium coriaceo-membranaceum subtriangulare?
Haustellum longum arcuato-incurvum valvulis paulo brevius.
Ocelli nulli.
Oculi parvi laterales lineares.
Tarsi unguibus subtus breviter unidentatis.
Alæ nullæ.

Synopsis Specierum.

I. HIPPOBOSCA.

1. *Maculata.* Scutello nigricante maculis tribus flavis; mediâ majore.
2. *Francilloni.* Scutello flavo immaculato.
3. *Equina.* Scutello nigro maculâ transversâ flavâ.
4. *Camelina.* Scutello fusco-ferrugineo maculâ longitudinali flavâ.

II. FERONIA.

1. *Spinifera.* Piceo-atra alis obscuris; angulo anali subhyalino-nitente, thorace anticè utrimque spinâ acutâ armato.
2. *Americana.* Lutescens, thorace angulis anticis in tubercula obtusa productis, alis subiricoloribus.
3. *Macleayi.* Luteo-flava, thorace angulis anticis in tubercula acuta productis, alis lutescentibus.

III. ORNITHOMYIA.

* *Antennæ magnæ deflexæ vaginam supertegentes: haustellum et vagina breves.*

a. *Labium apice rotundatum.*

1. *Australasiæ.* Capite pedibusque testaceis, corpore fusco.

2. *Nigricans.* Corpore nigricante, scutello thorace anticè pedibusque fuscescentibus.

b. *Labium apice arcuato-subemarginatum.*

3. *Erythrocephala.* Corpore perfusco, capite rubro, pedibus fuscescentibus.

** *Antennæ parvæ divergentes: haustellum et vagina elongatæ.*

4. *Viridis.* Pterigosteo extimo marginali apice curvato.

5. *Avicularia.* Pterigosteo marginali extimo recto.

IV. STENEPTERYX.

1. *Hirundinis.* Corpore pallidè fuscescente aut testaceo.

V. OXYPTERUM.

1. *Pallidum.* Corpore testaceo, abdomine fusco, alis acutis.
2. *Kirbyanum.* Corpore fusco-testaceo, alis acuminatis; apice rotundatis.

VI. MELOPHAGUS.

1. *Ovinus.* Corpore testaceo piloso.

Descriptiones et Synonymia Specierum.

I. HIPPOBOSCA.

1. Hippobosca maculata.

Tab. xxvi. fig. 11.—13.

H. scutello nigricante, maculis tribus flavis; mediâ majore.

Hippobosca equina ex India Orientali. *Fab. Syst. Ant.* 338. *lin.* 9.

Habitat in India Orientali haud infrequens.

Mus. Dom. Francillon, Marsham, MacLeay, Leach.

Caput flavum: *oculi* piceo-nigricantes: *labium* pallidè flavum: *haustellum* nigrum; *vagina* nigro-atra pilis canescentibus

vestita: *frons* flava; medio latè exarato obscuriore: *clypeus* politus flavus, mèdio tenuiter sulcato; margine pallido-brunneo; anticè acutè emarginatus; laciniis parùm divaricatis subtruncatis, posticè subrotundatus tenuiter emarginatus.

THORAX piceus flavo-maculatus irregulariter profundiùs-strigosus, striis sæpe confluentibus quasi crenulatis: *scutellum* nigricans aut intensè nigro-piceum maculis tribus flavis transversè dispositis, mediâ majore, margine postico albo-ciliato: *pectus* nigro-piceum transversim strigosum: *alæ* anticè inter pterigostea hyalinæ, posticè obscuræ; *pterigostea* picea basi flava: *pedes* fusco-lutescentes pallidè villosuli; anteriores immaculati; quatuor postici apice tibiarum annulisque femorum nigris; tibiis posterioribus medio nigris; *tarsi* picei; *ungues* atri.

ABDOMEN pilis cinerascentibus velutinum; lateribus sæpe nudis luteo-fuscis.

2. Hippobosca Francilloni.

Tab. xxvi. fig. 8.—10.

H. scutello flavo immaculato.

Habitat ———

MUS. Dom. MacLeay, Francillon.

CAPUT flavum: *oculi* atri: *labium* pallidum: *haustellum* luteum apice obscurius: *vagina* picea pilis albidis tecta: *clypeus* flavus medio longitudinaliter sulcatus, posticè rotundatus, anticè acutè emarginatus; laciniis parùm divaricatis lanceolatis: *frons* flava, medio latè exarato.

THORAX pallidus irregulariter strigosus disco piceo: *scutellum* pallidum immaculatum posticè pilis albidis ciliatum: *pectus* punctulatum pallidum lateribus piceo-atris, transversim strigosum: *alæ* obscuræ: *pterigostea* flava apice piceo-nigra: *pedes* testacei; anteriores immaculati; intermedii et posteriores tibiis femoribusque annulis duobus nigro-piceis orna-

tis : *tarsi* anteriores lutei; posteriores et medii obscuriores : *ungues* atri.

Abdomen fuscum pilis incanis obtectum.

3. Hippobosca Equina.

Tab. xxvi. fig. 4.—7.

H. scutello nigro maculâ transversâ flavâ.

Hippobosca pedibus tetradactylis, alis cruciatis, *Geoff. Ins.* ii. 547. 1. *pl.* 18. *f.* 1.

Hippobosca fusca, alis magnis fuscis, unguibus simplicibus, *De Geer, Ins.* vi. 275. 1. *pl.* 16. *fig.* 1, 2.

Musca Equina tenax, Act. Ups. 1736, p. 31. 27.

Hippobosca Equina, *Linn. Syst. Nat,* xii. i. 1010.

—— *Fn. Sv. ed. alt.* 1921.

Fab. Syst. Ant. 337. 2.

Panz. Faun. Ins. Germ. fas. 7. *tab.* 23.

Schell. Gen. des Mouch. dipt. tab. 42. *f.* 1.

Latr. Gen. Crust. et Ins. iv. 365.

Scop. Ent. Carn. 1022.

Schrank. Enum. Ins. Aust. 1007.

Pod. Mus. Græc. 120.

Vill. Ent. iii. 610. 1.

Fourc. Ent. Paris. ii. 504. 1.

Oliv. Encycl. Méth. Ins. vii. 91. 1.

Ross. In. Etrus. 337. 1591.

β Scutello toto flavo (mas?) Habitat in Europâ, Africâ.

Habitat in Europâ * frequentissima, equorum pestis, (Anglicè *Forest fly.*) β Mus. MacLeay, Leach.

Caput flavum; vertex pallidus utrinque setâ distinctâ nigrâ : *oculi* piceo-nigri : *labium* pallidum : *haustellum* nigrum : *vagina* piceo-atra pilis nigris vestita : *clypeus* pallidus medio longitudinaliter impressus, anticè acutè emarginatus; laciniis divaricatis obliquè subtruncatis, apice acutis : *frons* flava, medio latè exarata obscurior.

* *Var. α habitat in Ægypti capra, observ.* Savigny, *qui exemplum mihi communicavit anno* 1815.

THORAX nigro-piceus pallidè flavo-maculatus, irregulariter strigosus; striis sæpe confluentibus, nonnunquam etiam quasi crenulatus: *scutellum* nigro-piceum maculâ flavâ ovatâ transversâ notatum: *pectus* piceum lateribus obliquè strigosis atris: *alæ* obscuræ: *pterigostea* lutea fusco-marginata: *pedes* lutei pilis nigris obtecti; anteriores immaculati; tibiæ femoraque mediæ annulo unico, posteriores annulis duobus fuscis: *tarsi* lutei: *ungues* atri.

ABDOMEN luteum aut brunneo-luteum, pilis nigricantibus pallidisque obtectum.

4. Hippobosca Camelina.

Tab. xxvii. fig. 11.—14.

H. scutello fusco-ferrugineo maculâ longitudinali flavâ.

Hippobosca Camelina, *Savigny MSS.*

Habitat in Ægypti camelo.

MUS. Savigny, MacLeay, Nost. ex Savigny dono.

Duplo major H. equina.

CAPUT flavum: *oculi* piceo-atri: *labium* pallidum: *haustellum* flavum: *vagina* fuscescens: *clypeus* flavus, posticè puncto impresso, anticè emarginatus; laciniis apice rotundatis: *frons* flava, lateribus interne arcuatis, medio exarato obscuriore.

THORAX ferrugineo-fuscus flavo-maculatus irregulariter strigosus: *scutellum* fusco-ferrugineum maculâ longitudinali flavâ notatum: *pectus* sordidè-ferrugineum lateribus transversim strigosis; striis posticè arcuatis: *alæ* obscuræ: *pterigostea* lutea fusco-marginata: *pedes* sordidè lutei pilis pallidis obtecti: femoribus quatuor anticis, femoribus posticis apice tibiisque apice basique saturatioribus: *tarsi* fubferruginei: *ungues* atri.

ABDOMEN pallido-hirsutum; *dorsum* sordidè fusco-luteam: *venter* sordide fulvescente-luteum.

β Femoribus anticis concoloribus coxis pallidis, tibiis intermediis apice basique obscusioribus.

II. FERONIA.

1. Feronia spinifera.

Tab. xxvi. fig. 1.—3.

F. piceo-atra, alis obscuris; angulo anali subhyalino nitente, thorace angulis anticè utinque spinâ acutâ armato.

Habitat ———

Mus. Dom. MacLeay.

Caput nigrum: *oculi* rufi: *labium* albidum: *vagina* picea.

Thorax piceo-ater anticè spinâ acutâ utrinque armatus: *pectus* piceum: *alæ* obscuræ angulo anali subhyalino nitente: *pterigostea* picea; limbalibus basi pallidis: *pedes* supra picei, subtus testaceo-picei: *ungues* atri.

2. Feronia Americana.

Tab. xxvii. fig. 1.—3.

F. lutescens, thorace angulis anticis in tubercula obtusa productis, alis subiricoloribus.

Habitat in America, (Georgia.)

Mus. Dom. Francillon.

Caput lutescens: *oculi* atro-nigri: antennæ nigricantes: *labium* album: *haustellum* luteum: *vagina* picea pilis nigris obtecta: *clypeus* subquadratus luteus anticè latè emarginatus; laciniis divaricatis acuminatis: *frons* brunneo-lutea; marginibus elevatis glaberrimis: *vertex* elevatus glaberrimus luteus.

Thorax subbrunneo-luteus obscuriùs irregulariter strigosus depressione cruciformi notatus: *scutellum* subbrunneo-luteum medio impressum: *pectus* pallidum glabrum medio sulcatum lateribus subcrenulatis, anticè bifurcatum; laciniis rotundatis: *alæ* subiricolores: *pterigostea* picea et lutea: *pedes* lutei: *tarsi* obscuriores: *ungues* nigri.

Abdomen flavo-luteum punctulis nigris sparsum, basi medioque supra obscurius.

3. Feronia Macleayi.

F. luteo-flava, thorace angulis anticis in tubercula acuta productis, alis lutescentibus.

Habitat in Australasia.
Mus. Dom. Francillon.
Magnitudo omnino Ornithomyiæ viridis.

III. ORNITHOMYIA.

* *a.*

1. Ornithomyia Australasiæ.

Tab. xxv. fig. 6.—8.

O. capite pedibusque testaceis, corpore fusco.

Hippobosca Australasiæ, *Fab. Syst. Antl.* 337. 1.
Ornithomyia Australasiæ, *Oliv. Encycl. Méth. Insect.* viii. 544. 1.

Habitat in Australasia.
Mus. Dom. MacLeay.

Caput testaceum: *oculi* nigro-fusci: *labium* pallidum apice acutè subrotundatum deflexum: *vagina* fusca pilis saturatioribus vestita: *antennæ* testaceæ: *vertex* triangularis elevatus.

Thorax saturatè fuscus sublævis substrigosus: *pectus* testaceum politum anticè acutissimè bidentatum: *alæ* obscuræ: *pterigostea* marginalia picea, limbalia flava: *pedes* testacei: *tarsi* fusci apice albi: *ungues* atri.

2. Ornithomyia nigricans.

Tab. xxvii. fig. 7.—10.

O. nigricans, scutello thorace anticè pedibusque fuscescentibus.

Ornythomyia nigricans, *Latreille*, MSS.

Habitat in India, (Bengal.)
Mus. Brogniart, Latreille, Leach,—communicavit Latreille.

Caput fuscum: *oculi* piceo-atri: *labium* pallidum: *vagina* flavida apice fusca; *clypeus* testaceus: *frons* saturatè ferruginea: *canthus* oculorum externè et *vertex* flavi.

Thorax fusco-ferrugineus irregulariter strigosus, antice saturatè ferrugineus: *scutellum* saturatè ferrugineum aut luteum: *pectus* ferrugineo-luteum: *alæ* subfuscescentes: *pterigostea* marginalia fusco-ferruginea, limbalia albida: *pedes* sordidè viridescentes femoribus supra tibiis lateraliter tarsisque nigricantibus: *ungues* atri.

Abdomen sordidè testaceum pilis nigricantibus vestitum: *dorsum* nigricans.

* *b.*

3. Ornithomyia erythrocephala.

Tab. xxvii. fig. 4.—6.

O. corpore perfusco, capite rubro, pedibus fuscescentibus.

Habitat in Brasiliis.

Mus. Britann. Communicavit Dom. Reid.

Caput rubrum infra sordidè viridescente-testaceum: *labium* albidum.

Thorax perfuscus anticè sordidè testaceus: *scutellum* perfuscum: *pectus* sordidè viridescente-testaceum: *alæ* pallidè fuscescentes: *pterigostea* marginalia fusca, limbalia albida: *pedes* fuscescentes infra sordidè viridescente-testacei: *tarsi* quatuor anteriores sordidè testacei nigro-marginati, posticè nigri: *ungues* atri.

Abdomen luteum nigricante-hirsutum: *dorsum* saturatius.

4. Ornithomyia viridis.

Tab. xxv. fig. 1.—3.

O. pterigosteo extimo marginali apice curvato.

Hippobosca viridis alis hyalinis fuscis, *De Geer, Mém. sur les Ins.* vi. 285. 2. *pl.* 16. *f.* 21, 22.

Hippobosca Corvi, *Scopol. Ent. Carn.* 1026.
Oliv. Encycl. Méth. Insect. vii. 92. 4.

Ornithomyia viridis, *Latr. Hist. Nat. des Crust. et des Insect.* xiv. 402.
Latr. Gen. Crust. et Insect. 4. 362.
Oliv. Encycl. Méth. Insect. viii. 544. 2.

Habitat in Angliæ, Galliæ turdis, corvis, picis frequens.

Caput testaceum: *oculi* nigricantes: *labium* album: *gula* polita lævis cornea testacea lucida: *haustellum* pallidum: *vagina* fusca.

Thorax fusco-viridis suturis pallidioribus: *scutellum* fusco-viride: *pectus* viride-glabrum politum anticè latè emarginatum; laciniæ breves divaricatæ subobscuræ: *alæ* hyalinæ subobscuræ: *pterigostea* testacea fusco-marginata, limbalibus albidis: *pedes* virides: *tarsi* virides apice picei: *ungues* piceo-nigri.

Abdomen cinereo-viride nigro hirsutum: *venter* basi utrinque processu ovato subcoriaceo-membranaceo pallido instructum.

Sexus alter?

Var. β. Pectore anticè acutè emarginato, laciniis subcompressis dentiformibus.

Habitat in Angliæ Corvo monedulâ.

Mus. MacLeay, Leach.

Caput testaceo-fuscum: *oculi* nigri: *labium* album: *vagina* supra testacea, subtus fusca: *gula* polita lævis cornea testaceo-fusca.

Thorax fuscus suturis testaceis: *scutellum* fuscum: *pectus* politum glabrum anticè acutè emarginatum; laciniæ dentiformes subcompressæ apice subacutæ: *alæ* obscuræ: *pterigostea* picea,

limbalia sordidè albida: *pedes* virides: *tarsi* virides apice nigri: *ungues* nigri.

ABDOMEN obscurum lateribus nigro-ciliatis.

Hæ varietates sexûs mihi videntur.

5. Ornithomyia avicularia

Tab. xxv. fig. 4; 5.

O. pterigosteo marginali extimo recto.

Ornithomyia avicularia, *Linn. Syst. Nat.* xii. 1
—— *Fn. Sv.*
Vill. Ent. iii. 610. 2.

Habitat in Galliâ vulgatissimè; in Angliæ Tetraone tetrice et in alauda *pipit* dicta rariùs *.

MUS. Linn. Samonelle, MacLeay, Stephens, Leach.

CAPUT fusco-viride aut testaceum: *oculi* picei aut nigri: *labium* album: *vagina* fusca.

THORAX fusco-viridis aut testaceus suturis lineisque pallidioribus: *pectus* politum viride aut testaceum: *alæ* subobscuræ: *pterigostea* picea limbalibus testaceis.

ABDOMEN viridescente fuscum: *venter* utrinque basi sæpius processu ovato instructum.

* Mense Decembre in Danmonia meridionali legit Pater meus.

IV. STENEPTERYX.

1. Stenepteryx Hirundinis.

Tab. xxv. fig. 9.—11.

S. corpore pallidè fuscescente aut testaceo.

Hippobosca hirundinis, *Linn. Syst. Nat.* xii. 1.
—— *Fn. Sv.*
Scopol. Ent. Carn. 1023.
Vill. Ent. iii. 611. 3.
Fourc. Ent. Par. ii. 504. 2.
Ross. Fn. Etrusc. si. 337. 1592.
Walck. Fn. Par. ii. 416.
Ornithomyia hirundinis, *Latr. Gen. Crust. et Insect.* iv. 362.
Oliv. Encycl. Méth. Insect. viii. 544. 3.
Hippobosca pedibus sexdactylis alis divaricatis, *Geof. Ins.* ii. 54. 7. 2.

Habitat in Hirundine urbica.

Caput fuscescens: *oculi* piceo-nigri: *labium* album: *gula* cornea polita: *haustellum* testaceo-fuscum: *vagina* fusco-testacea: *facies* fusco-testacea: *vertex* polita.

Thorax fuscus strigosus: *pectus* politum glabrum anticè productum acutèque emarginatum: *alæ* hyalinæ: *pterigostea* testaceo-viridia: *pedes* virides: *ungues* piceo-nigri.

Abdomen fuscum posticè emarginatum.

V. OXYPTERUM.

1. Oxypterum pallidum.

Tab. xxv. fig. 12.—14.

O. testaceum, abdomine fusco, alis acutis.

Hippobosca, *Schæff. Elem. Ent. tab.* 7.
——— *Icon. Insect. Ratisb.* 53. *f.* 1, 2.
Ornithomyia pallida, *Oliv. Encycl. Méth. Insect.* viii. 544. 5.

Habitat in (Cypselo nigro) Hirundine apum, *Linn.*

Caput testaceum: *oculi* fusci: *labium* album: *haustellum* saturatè fusco-testaceum; *vagina* fusco-testacea nigro-pilosa: *antennæ* testaceæ nigro-ciliatæ.

Thorax subquadratus glaber anticè profundè emarginatus; laciniis productis pilosis: *scutellum* pilosum: *pectus* glabrum transversim substrigosum: *alæ* hyalinæ: *pterigostea* viridescente-fusca, costali apice subsaturatiore: *pedes* fusco-testacei: *tarsi* obscuriores: *ungues* atri.

Abdomen fuscum.

2. Oxypterum Kirbyanum.

Tab. xxv. fig. 15, 16.

O. fusco-testaceum, alis acuminatis apice subrotundatus.
Habitat in Anglia.
Mus. Kirby, qui in com. Suffolk semel legit.

Caput fusco-testaceum: *oculi* fusci: *labium* album: *haustellum* ——: *vagina* saturatè fusca valdè pilosa: *antennæ* testaceæ nigro-ciliatæ.

Thorax subquadratus crenulatus anticè profundè emarginatus; laciniis productis pilosis: *pectus* transversim strigosum: *alæ*

hyalinæ; *pterigostea* testacea, costali vix apice saturatiore: *pedes* fusco-testacei: *tarsi* lati obscuriores: *ungues* atri.

ABDOMEN fusco-testaceum.

VI. MELOPHAGUS.

1. Melophagus ovinus.

Tab. xxvi. fig. 14, 15.

M. testaceus pilosus.

Hippobosca ovina, *Linn. Syst. Nat.* xii. 1.
—— *Fn. Sv.*
Vill. Ent. iii. 611. 4.
Fab. Syst. Antl. 339. 7.
Schrank, Enum. Insect. Aust. 1008.
Oliv. Encycl. Méth. Insect. vii. 92. 5.
Panz, Fn. Insect. Germ. 51.—14.
Melophagus ovinus, *Latr. Dict. d'Hist. Nat.* 24. 197. 598.
—— *Hist. Nat. des Crust. et des Insect.* xiv. 403.
—— *Gen. Crust. et Insect.* iv. 363.

Habitat in Ovem arietem.

CAPUT testaceum: *oculi* picei.

THORAX testaceus: *pectus* punctulatum: *pedes* testacei: *ungues* nigri.

ABDOMEN fusco-testaceum.

Hippobosca 1. Vespertilionis et 2. Longipennis, *Fabr. Syst. Antl.* 3. Cervi, *Oliv. Encycl. Méth.* 4. Uralensis, *Gmelin*; necnon Ornithomyia 1. Turdi, 2. Brunea, *Oliv. Encycl. Méth.* Insecta mihi invisa.

Eproboscideorum species omnes petit W. E. Leach.

TABULARUM EXPLICATIO.

TAB. XXV. Fig. 1. Ornithomyia viridis, mag. nat.
2. O. viridis caput auctum.
3. O. viridis ala amplificata.
4. Ornithomyia avicularia, mag. nat.
5. O. aviculariæ ala ampl.
6. O. Australasiæ, mag. nat.
7. et 8. O. Australasiæ caput et ala ampl.
9. Stenepteryx hirundinis, mag. nat.
10. et 11. S. hirundinis ala et caput auct.
12. Oxypterum pallidum.
13. et 14. O. pallidi ala et caput auct.
15. Oxypterum Kirbyanum, mag. nat.
16. O. Kirbyani ala amplificata.

TAB. XXVI. Fig. 1. Feronia spinifera, mag. nat.
2. et 3. F. spiniferæ caput et ala ampl.
4. et 5. Hippobosca equina, mag. nat.
6. et 7. H. equinæ caput et ala auct.
8. Hippobosca Francilloni, mag. nat.
9. et 10. H. Francilloni ala caputque auct.
11. Hippobosca maculata, mag. nat.
12. et 13. H. maculatæ ala et caput auct.
14. Melophagus ovinus, mag. nat.
15. M. ovini caput auctum.

TAB. XXVII. Fig. 1. Feronia Americana, mag. nat.
2. ——— ——— capite amplificato.
3. ——— ——— alâ auctâ.
4. Ornithomyia erythrocephala, mag. nat.
5. O. erythrocephalæ caput auctum.
6. Ejusdem ala aucta.
7. Ornithomyia nigricans, mag. nat.
8, 9. et 10. Pes anticus, caput alaque O. nigricans, mag. nat.
11. Hippobosca cameli, mag. nat.
12. H. cameli caput auctum.
13. Ejusdem ala amplificata.
14. ——— pes auctus.

XXXIII. *On the Arrangement of Œstrideous Insects.*

By William Elford Leach, Esq.

(Read 6th April 1811.*)*

ŒSTRIDEA.

Character Essentialis.

Alæ duæ.
Os clausum; instrumentis cibariis imperfectis.

Genus I. ŒSTRUS.

Œstrus auctorum.
Alæ cellulis duabus limbalibus exterioribus perfectis; interioribus terminalibus.
Thorax superficie inæquali.
Abdomen apice deflexum: fœminæ acuminatum.
Oculi distantes; maris approximatiores.

* *Thorax punctis elevatis scabriusculus.*

Sp. 1. *Ovis.*
Œstrus ovis, *Linn.—Clark, Trans. Linn. Soc.* iii.

** *Thorax maculis glabris nitidis nudis tessalatus.*

Sp. 2. *Bovis.*
Œstrus bovis, *Clark, Trans. Linn. Soc.* iii.

Sp. 8. *Ericetorum.*

Œ. fulvescens, collo thorace posticè abdomineque basi supernè albido-villosis, thorace suprà abdomine dorso femoribusque nigris.

Œstrus hæmorrhoidalis, β *Clark, Trans. Linn. Soc.* iii. 328.

Habitat in Ericetis tempore vernali. Minor Œstro Bovis.

Gen. II. GASTEROPHILUS.

ŒSTRUS, *Auctorum.*

Alæ cellulis limbalibus omnibus terminalibus.

Thorax superficie lævi.

Abdomen apice inflexum : FŒMINÆ valdè elongatum attenuatum.

Oculi in utroque sexu æqualiter distantes.

Sp. 1. *Equi.*

Œstrus bovis, *Linn. Syst. Nat.*

Œstrus equi, *Clark, Trans. Linn. Soc.* iii.

Sp. 2. *Hæmorrhoidalis.*

Œstrus hæmorrhoidalis. *Linn. Syst. Nat.* 970.

Sp. 3. *Clarkii.*

G. capite thorace pedibusque fulvo-villosis ; abdomine nigro fascia villosâ basi pilisque albidis.

Habitat in Anglia Occidentali. Apud Bantham prope Kingsbridge a meipso captus.

XXXIV. *Observations on some Species of the Genus* FALCO *of* LINNÆUS.

By JAMES WILSON, Esq.

(Read 1st February 1817.*)*

I am induced to lay the following observations before this Society, with the hope of exciting the attention of its members to a subject in natural history, which has been much neglected in this quarter of the island, and which, from our natural opportunities, we certainly have the means of cultivating to greater advantage, than our southern neighbours.

I am aware of the numerous subdivisions which have been recently made in the Linnæan genus *Falco*, but do not consider it necessary to adopt them in this paper, as part of the subject may be more clearly illustrated by adhering to the more generally received and familiar terms.

F. fulvus. F. chrysaëtos.

It is the prevailing opinion among many French ornithologists of the present day, that the *Falco fulvus*, or Ring-tailed Eagle, is specifically the same as the *Falco chrysaëtos*, or Golden Eagle.

Having lately examined several of the continental collections, I have had an opportunity of observing the variations presented by age and sex, and the effects of climate on many species of the feathered race.

In the celebrated collection of Swiss birds, formed by the late M. Sprungli of Berne, the specimen of the Golden Eagle resembles in all respects, that in the Parisian cabinet; but the bird in the latter collection, supposed to be the young of that species, by some of the French naturalists, though described as a distinct species by preceding writers on ornithology, under the name of *F. fulvus*, or Ring-tailed Eagle, is not the same as the young of the Golden Eagle preserved by M. Sprungli.

This, conjoined with some other circumstances, induces me in this instance, to doubt the accuracy of the Parisian nomenclature.

In the Swiss specimen, which is known to be the young of the Golden Eagle, the tail has no appearance of a ring or band at the base. The feathers there, are bluish-black, barred with brown and ash colour, the overlying central tail feathers being likewise barred, but the ground colour is brownish-black. The bill is of a deep blue co-

lour, darker towards the tip. Cere and irides yellow. Head and neck brown and tawny; the feathers long and pointed, and, particularly towards the back of the neck and hinder part of the head, tinged with bright ferruginous or rust colour. The general colour of the plumage is dark brown, with shades of tawny and ferruginous. Quill-feathers, of a chocolate colour, with white shafts. Legs yellow, large, and feathered to the toes; toes large and scaly; claws black. It bears a close resemblance to the adult bird, but the feathers on the thighs are lighter in colour, and spotted irregularly with white.

To enable us to compare the two species, it will be necessary to give an accurate description of the *Ring-tailed Eagle*.

The bill is bluish-horn colour, with a black tip. Cere yellow. Irides hazel. Head and neck brownish-black, mixed with rust colour. Feathers on the lower part of the back of the neck, of a ferruginous white colour at their extremities. Chin, throat, breast, and belly, black; some of the feathers tinged with brown towards the base. Feathers on the thighs brownish-black, with paler points. Legs feathered down to the toes, with short downy plumes, of a hair-brown colour. Back, scapulars, and primary and secondary quill-feathers, black. Lesser wing coverts, black and blackish-brown, mixed with hair-brown. Greater wing coverts, brownish-black. There are a

few pale brown feathers on the angle of the shoulder. Tail perfectly white for two-thirds of its length, and black at the extremity. Vent-feathers, and under tail-coverts, brown and white intermixed. Feet yellow; claws black. On the whole, the Ring-tailed Eagle is much darker, and more uniform in its plumage than the Golden Eagle, and the broad white band on the tail, is a distinguishing character, and which, according to PENNANT, it maintains through every stage of life, and in all countries where it is found. The colour of the irides is also different; but this character being subject to change, cannot be insisted on as a specific distinction.

Besides these particulars, certain general considerations strengthen the belief of their being distinct.

In Britain, the Golden Eagle has always been very rare; yet, amongst the Western Isles, and Highlands of Scotland, as I have myself had an opportunity of observing, the Ring-tailed Eagle is not uncommon, being well known under the name of Black Eagle. I never understood, that in France, Germany, or Switzerland, the Golden Eagle was abundant, yet the species about to be confounded with it, is called *L'Aigle commun* by BUFFON, and the other French naturalists of the last century.

Colonel MONTAGU, whose accuracy in the discrimination of specific character, no one will feel

inclined to doubt, never supposed the possibility of their belonging to the same species. In his Supplement to the Ornithological Dictionary, he mentions the *Falco fulvus*, as a species which had been observed by himself in a wild state in the Highlands of Scotland; but, under the title of Golden Eagle, he states his opinion of the extreme rarity of *Falco chrysaëtos*, and adds, that during the long period of his own ornithological studies, no individual of that species had ever fallen under his examination, or been observed by him in any British collection, except that of Sir Ashton Lever, now dispersed. From this circumstance, among others, I incline to the opinion of their being distinct; because, had they been actually the same, the one must necessarily have been as common as the other, and in that case, would not have escaped the notice of so unremitting an observer.

Besides, if the birds in question were specifically the same, and supposing the white band to be merely the colour of immaturity, would not the individuals in the more advanced state of plumage approximate more nearly to the adult bird, so that, by degrees, all distinctions must be effaced, and they could not be recognised but as one and the same? whereas, on the contrary, I have found that the more perfect the plumage of the bird becomes, the more apparent are those characters which have hitherto entitled it to rank as a distinct species, and that it is chiefly between the

young of the two species that there is a difficulty in discriminating.

On what ground, therefore, can a strongly marked and constant difference in the plumage of two birds, be accounted for, but on the supposition of their being distinct, particularly when that difference, instead of gradually disappearing as they approach maturity, and which, if it were the result of immaturity, it must necessarily do, becomes every day the more obvious and defined?

An examination of the fine specimen of the full-fledged Ring-tailed Eagle, now exhibited, will carry conviction, that it is not in the plumage of immaturity *.

* I find in CUVIER's late work on Natural History, that he does not credit the supposition of the two species above described being the same.

I may here state the opinion of that illustrious observer concerning the *F. albicilla* and *F. ossifragus*, from which it would appear, that these birds, though long described under different names, are not really distinct. His words are: "Ne forment qu'une espèse qui, dans ses premières années, a le bec noir, la queue noirtâre, tachetée de blanchâtre, et le plumage brunâtre, avec une flamme brun-foncé sur le milieu de la plume (enl. 112. et 415.) et qui, avec l'age, devient d'un gris-brun uniforme, plus pâle à la tête et au cou, avec une queue toute blanche et un bec jaune-pâle, (Frisch, 70. †)"

† "On a vérifié plus d'une fois ce changement a la ménagerie du Muséum." He further observes in the same note:

"Quant au *petit pygargue*, *F. albicaudus*, ce n'est que le mâle du grand *F. albicilla*."

I am informed by M. STETTLER of Berne, keeper of the *Sprunglian Cabinet*, that it is ascertained beyond the possibility of doubt, that the Honey Buzzard, (*Falco apivorus*, LINN.) and the Whitish Buzzard, the *Falco albidus* of GMELIN'S *System*, (p. 267. No. 79.) are the same species; the former being the female, the latter the male. F. apivorus. F. albidus. F. variegatus.

Though the plumage differs greatly, yet the general figure of the birds, the form of the bill, shape of the head, and other unvarying characteristics, are in favour of the truth of this opinion. One objection, however, immediately occurred to me, which was, that though the *F. apivorus* is not uncommon, no individual resembling the *Falco albidus* had ever been seen in Britain. This I mentioned to some of the Swiss ornithologists, and they were as unable as myself to reconcile such a seeming contradiction. But as the fact of their being actually the same species, has been proved by the only perfectly conclusive method, that of rearing the young birds, nothing more could be objected. Nor in truth, on consideration, does the objection hold good.

If these observations are correct, our *Sea Eagle*, and the *Lesser White-tailed Eagle* of Latham, (*F. albicaudus* Gm.) should in future be considered as synonimous with the *White-tailed* or *Cinereous Eagle* of English ornithologists, and the specific name of *albicilla* should be retained as applicable to the species in its adult state.

No European ornithologist has any doubt of the Hen Harrier and Ring-tail (*F. cyaneus* and *F. pygargus*) having been properly identified as male and female. Yet supposing the objection urged above to be valid, a North American naturalist might with equal justice deny that the difference between the two last-mentioned birds is merely sexual, from the circumstance, as singular and little accounted for, that no bird in the plumage of the Hen Harrier has been observed in America, though the Ring-tail is well known there. It thus appears, that, under certain modifications of climate, the change in the plumage of the male does not take place, but that of the female is retained; and this opinion I find confirmed by a remark of Dr PALLAS. "The Ring-tail (he says) is extremely common in Russia as well as in Siberia. In more temperate, and open countries, it is certainly not to be distinguished from the Hen Harrier."—LATHAM'S *first Supplement*, p. 24.

What the *Falco cyaneus* is in America the *Falco albidus* is in Britain, and the history of the changes in the plumage of one species being well known, leaves us in little doubt as to those of the other.

It still, however, remains a problem difficult of solution, that in one species, a change which we usually consider as allied to those frequently observable in cold climates, should be effected in France and Switzerland, and resisted in Britain;

and that in another species, an analagous change should take place in Britain, and be resisted in North America.

What LATHAM anticipated, has now taken place. Speaking of the *Ring-tail*, he observes, "The above hints may urge others to make further observations, in order to procure a certainty in this; and may, at the same time, lead us to discriminate other birds supposed of different species, perhaps proving on a more intimate acquaintance, to be merely owing to opposition of sex."

To the *Falco apivorus*, it is probable that another species is also referable. Dr GMELIN gives the *Falco albidus* and *Falco variegatus*, or Speckled Buzzard, as separate species, though he mentions in a note his suspicion of their being the same. Dr LATHAM, however, considers them as forming one species, and in his *Index Ornithologicus*, (p. 24. No. 48.) refers to both GMELIN's species as synonyms.

If the *Falco albidus*, or Whitish Buzzard, is admitted to be specifically the same as the *Falco apivorus*, or Honey Buzzard, it follows, that such birds as have been described as varieties of the one pertain likewise to the other; so that if the Speckled Buzzard be really identical with the *Falco albidus*, it should, in common with the latter, be considered as synonimous with the Honey Buzzard.

The general characters of the Speckled Buzzard, certainly agree well with this supposition,

and it is interesting from another circumstance. It affords, as it were, the connecting link between the two other varieties, and presents itself in a state of plumage intermediate between the *Falco albidus* and Honey Buzzard, furnishing an additional proof, if such were wanting, that these birds are specifically the same.

Although the *Falco variegatus*, or Speckled Buzzard, in its plumage resembles more nearly the Honey Buzzard or female, than the Whitish Buzzard or male, I should be inclined to consider it, on account of its inferior size, as an immature bird of the male sex; it being well known, that in such species as differ essentially in the plumage of the sexes, the young males are at first not to be distinguished from the females, and for many months bear a striking resemblance to them. It may therefore be considered as a young male about to attain the plumage of maturity, at least, such as distinguishes that state in some continental countries.

I shall next describe briefly, and in as characteristic a manner as possible, the three varieties which I am of opinion should be referred to the *Falco apivorus* or Honey Buzzard.

The first is that described as a distinct species, under the name of *Falco albidus*. This is of the male sex. The legs are yellow; body white with

brown spots. Tail brown, barred, and spotted with white*.

The second, and connecting variety, is the *Falco variegatus* of GMELIN, the *Speckled Buzzard* of LATHAM'S Synopsis, and *Buzzardet* of the Arctic Zoology. The head and neck are whitish; the shaft of each feather irregularly marked with rusty-brown. The prevailing colour of the upper plumage is brown, but several of the feathers, especially on the wing-coverts, are spotted with white. The tail is dark brown, crossed by several nearly obselete bands of a paler hue. Under parts white, with longitudinal brown spots,

* The German ornithologists consider the *F. albidus* as a distinct species, but nearly allied to the *F. buteo* of LINN. BECKER says, he has examined it in its young and old state, and considers it as a distinct species, and in this opinion he is followed by BECHSTEIN, who is further inclined to consider PENNANT'S *Buzzardet* as a variety of the *F. albidus*.

CUVIER, on the other hand, is of opinion that the *Falco communis fuscus, F. variegatus, F. albidus, F. versicolor*, GM. " ne sont que différens états de la buse ordinaire."

In regard to the *F. versicolor*, the *Spotted Falcon* of the British Zoology, I may remark, that Dr SHAW, in his General Zoology, gives it as a variety of the Common Falcon. MONTAGU, from its superior size and predominance of white plumage, suspects it to be a variety of the *Ger-Falcon*.

which increase in size as they approach the belly *.

The third, and most common variety, is that described as the *Falco apivorus*, the Honey Buzzard of the English ornithologists. The legs, as in the preceding varieties, are yellow. Head, ash-coloured. Upper parts, brown. Under parts white, and either spotted or barred with rusty-brown, according to the age of the individual. The younger birds, like the preceding variety, being marked on the breast and belly with longitudinal-shaped spots, which in the adults are disposed in regular bars. The tail is brown, and barred with different shades of the same colour. These bars seem to vary in number, as LINNÆUS says there is only one, LATHAM two, and PENNANT three, and the specimen described by ALBIN was without any bars on the tail.

From the preceeding description, it will be seen, that these varieties are intimately connected, and doubtless, if many specimens could be procured of different ages, and from various climates, they would be found to approach each other by almost imperceptible gradations.

* The *F. variegatus*, BECHSTEIN considers to be a variety of *F. buteo*.

There is no subject in ornithology, so intricate and confused as the natural history of the Falcon tribe, and almost every endeavour to illustrate this branch of the science by the accurate description of species, has unfortunately tended to increase the darkness which surrounds it.

Without attending to those changes which are incidental to age or sex, to the climate of particular countries, or the season of the year, naturalists have assumed, that such individuals as differed remarkably in the general colour and markings of their plumage, were specifically distinct, and thus as many species have been created, as there are variations in the transition from youth to age.

Another great source of error originates in the misconstruction and improper application of the technical language of Falconry, and in the indefinite nature of that language itself.

Certain terms intended, in the first instance, merely to designate the degree of excellence to which individuals of different species may have attained in the sports of the field, have been applied by naturalists as the specific appellation of particular kinds; and being again introduced into the language of falconry, with a signification altogether

different from that which they were originally intended to express, they have occasioned a confusion which it will be difficult to clear up, as long as such vague and indefinite expressions are permitted in scientific details.

As this confusion has probably originated in the terms of falconry not being understood by ornithologists, it may not be improper before entering into an examination of the history of particular species, to mention a few of the terms in most common use, and their proper application to the sports of the field.

We find, on referring to books on falconry, that the term *Gentle* or *Gentil*, was not originally applied to distinguish any particular species of hawk, but merely to characterise such individuals of different species as were *manny* or manageable, that is, tamed, and trained to kill game, and sufficiently docile to be used in the fields. It was soon, however, considered as the name of a species, and accordingly occurs both in systematic works on natural history, and in modern treatises on falconry, with this erroneous signification. Thus, it is described under the name of *Falco Gentilis*, by GESNER, ALDROVANDUS, WILLUGHBY, RAY, ALBIN, BRISSON, LINNÆUS, PENNANT, and LATHAM; and CAMPBELL, in his treatise on Modern Falconry, under the chapter entitled, "Of the chusing of the Faulcon Gentle," says, "This bird has received the epithet of Gentle, on ac-

count of her mildness, and easiness to be reclaimed. No hawk exceeds her in strength according to her size, or is hardier to endure fatigue. She is excellent to sport with at either field or brook."

The next term which I have to notice, is the word *Haggard*. This expression has not been so generally applied as a specific name, but it has occasioned some confusion. Thus, we find a bird described sometimes as a variety, at other times as a distinct species, under the titles *Falco gibbosus*, *Le Faucon hagard, ou Bossu*, and in English, under the name of *Haggard Falcon*. It is now, however, said to be only the Common Falcon, arrived at an age when the bird is fond of sitting with its neck shortened, and the head sunk between the shoulders, assuming a deformed appearance. Thus, LATHAM, speaking of the *Falco gibbosus*, says, " Hic jam ad senectutem provectus est ; tum collum contorquet, illudque inter scapulas quasi abscondit, ita ut gibbum gestare videatur ; unde *gibbosi* nomen."

This explains very properly the application of the Latin specific name, but does not apply to the English term Haggard, which is a sporting expression, and does not seem to have been satisfactorily explained in any scientific work. In books on falconry, I find that it has never been applied to any particular species, whatever its external appearance might be, but in the language of the field denotes a hawk taken wild from the sky by

means of a lure, in contradistinction to those that are reared from the eyrie. In old books on the subject, there are chapters with such titles as these: "Of the Haggard Falcon:" "Of the Superiority of the Falcon from the Eyrie over the Haggard Falcon:" "Of reclaiming the Haggard Falcon," &c.; and there is likewise frequent mention made of the Haggard Gyr-Falcon, and the Haggard Goshawk, the latter of which is said to be of all others the wildest, and consequently most difficult to be reclaimed. In a work entitled the *Gentleman's Recreation*, published in 1674, there is a chapter allotted to the Sparrow Hawk, in which the different varieties of that species are described. The enumeration concludes thus: "Lastly, *Haggards* are they which prey for themselves, and do also mew in the woods or at large. This division of kinds is not peculiar to the Sparrow Hawk, but common to all," &c.

Haggard Falcons were much esteemed by some falconers on account of their superior strength and velocity; but two objections have been brought against them. They are naturally given to *check*, that is, to fly away from game after rooks and pigeons, for when they drive the game into cover, unless the falconer be active in *serving them*, and careful to keep them low and nigh himself, they *rake off* or fly from the game with the first birds that spring. The second objection arises from

the first; for when they are *fu'footed* in the evening, that is, have struck a bird, and cannot be found that night, they are apt to fly away next morning before the falconer comes to the field in search of them, being well acquainted with the country, accustomed to shift for themselves, and consequently able to live without human assistance. On the other hand, hawks from the eyrie, are said to be free from checking, and will remain where they are lost for some days, or, if they know the ground, will fly home to the *heck* or place, where they have been accustomed to be fed *.

The term Haggard, therefore, was applied to every hunting hawk, without regard to its species, which had been reclaimed from a state of nature after it had left the eyrie. It did not apply to any peculiar character in its external aspect, but to the less degree of confidence which could be placed in it, and its greater liability to prove *false* or forsake its master. That this is the true signification of the word, may be learned from the writings of the old dramatists, who were particularly fond of allusions borrowed from the art of falconry. For example, in SHAKESPEARE'S *Othello*, where the Moor begins to suspect the

* CAMPBELL'S *Treatise on Falconry*.

fidelity of his wife, we have the following passage:

> "If I do prove her *haggard*,
> Tho' that her jesses were my dear heartstrings,
> I'd whistle her off, and let her down the wind
> To prey at fortune."

And without multiplying quotations, it may be observed, that the old English word *haggard*, is most generally used in a similar acceptation.

Falcons are likewise known by different names, according to their age or sex. Thus, the young females are called *Red Hawks*, or *Red Falcons*, and the young males *Red Tercels*.

When full grown and feathered, the females are called *Falcons*, and the males *Tercels*. These expressions, however, are not confined to the Peregrine Falcon, as MONTAGU seems to suppose, but are applied to different species *.

While they continue in the eyrie, they are called *Eyesses*, and afterwards are known by the different names of *Ramage Hawks*, *Soar Hawks*, *Slender Hawks*, *Carvists*, and *Enter-Mews*; and to these, and very many more, there have been corresponding varieties, or even species, described by naturalists.

* The name of *Tercel* is applied to male hawks, on account of their being usually one-third less than the females.

Brisson enumerates not fewer than twelve varieties of the Common Falcon, without including the Falcon Gentle, or a doubtful species called the *Lanner*, and in this list, he is followed by Latham, with the exception of the *Sacre* *, which the latter author is of opinion should constitute a distinct species.

I shall now take a short review of the different opinions entertained by ornithologists regarding particular species of the genus *Falco*; adding such observations as have occurred to me from an inspection of several interesting series of varieties.

In the opinion of Buffon, the Gentle Falcon is the Common Falcon in full plumage.

That it is the Common Falcon, there cannot be any doubt; but it is equally certain, that it is that bird in a state of immaturity, the Common Falcon, as will be afterwards seen, being transversely barred in the adult state. F. gentilis.

Brisson, Linnæus, Pennant, Sonnini, and Daudin, describe the Gentle Falcon as a distinct species. I trust what has been already said concerning the original application of the term *Gentle*, is sufficient to shew the inaccuracy of that opinion.

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* Cuvier is of opinion, that the *Sacre* is synonimous with the *Ger-Falcon*.

F. gentilis. In the earlier works of LATHAM, it is described as distinct. In the *Second Supplement*, however, to the *General Synopsis* of that author, we find the following observation: " The young of the Goshawk is very different from the adult, and it is not at all clear, that the Falcon Gentil of the British Zoology, No. 50., is not the Goshawk in its first feathers." The truth of this remark, is confirmed by a comparison of the specimen of the Goshawk now before you, with the figure of the Gentle Falcon given by PENNANT in his British Zoology*.

MONTAGU, in his last work, entirely coincides in the above opinion; and, on this subject, I may add that Colonel THORNTON, of sporting celebrity, applies the term *Gentil* to the Peregrine Falcon †.

The difficulty of identifying the Falcon Gentle, results from the desire of tracing it to one species, when it is clear, upon examination, that the young males and females in a particular state of plumage, both of the Common Falcon, as it is called, and of the Goshawk, have been described under that appellation.

* The figure referred to, is the 21st plate of the last edition.

† BECHSTEIN says, the *Falco gentilis* is the yearling bird of the *F. palumbarius*.

In some authors, we find the Falcon Gentle described as somewhat larger than the Goshawk. Its bill of a lead colour. Cere and irides yellow. The head and upper part of the neck rusty, streaked with black. The back and wings brown; scapulars tipped with rusty; quill-feathers dusky, outer webs barred with black; the lower part of the inner webs marked with white. Tail long, and marked with alternate bars of black and ash colour, and tipped with white. The legs yellow; claws black. *The wings extend exactly to the tip of the tail.* F. gentilis.

I consider this bird as one of the numerous varieties of the Common Falcon, as it agrees with that species in its early plumage. It is well distinguished from every modification of the Goshawk by the length of the wings.

Other authors have described the Gentle Falcon in a somewhat different manner, viz. Bill, cere, and irides, as in the former. Head inclining to ferruginous, with oblong black spots; upper part of the body and wings brown; each feather of the last tipped with ferruginous. The whole under sides yellowish-white, the points of each feather marked with heart-shaped spots; coverts of the wings and scapulars, brown, edged with rust colour. Tail barred with black and cinereous alternately. Legs yellow; claws black. *The wings extend only half the length of the tail.*

F. gentilis. The bird now described, I have no doubt is the young of the Goshawk. It is at once distinguished by the shortness of its wings; and an examination of the specimen of the immature Goshawk now exhibited, will shew the agreement of the other characters.

On this subject, I have to correct a slight mistake committed by MONTAGU. Having described the Gentle Falcon, he adds, "A variety supposed to be young birds, are described to have transverse bars on the breast." Now, the reverse of this is really the case. I have examined many specimens both of the Goshawk and Peregrine Falcon, and have always found that the young birds are marked with longitudinal spots, and do not acquire the barred plumage of the breast till they are nearly mature. The error seems to have originated with PENNANT, who not being acquainted with the nature of the changes in the plumage of hawks, has described the young birds as distinguished by transverse bars, instead of cordated spots, which he supposes to characterise such as are mature.

The observation, however, affords a further proof of the Gentle Falcon being merely the young of another species, as the varieties alluded to by MONTAGU, are the individuals about to assume the plumage of the adult Goshawk.

We may fairly conclude, that such authors as have described the Gentle Falcon with the wings

reaching to the end of the tail, have confounded the Common Falcon in a state of adolescence, and that those who characterise it by the wings extending only to the middle of the tail, have described the immature Goshawk. The name of *Falco gentilis*, should therefore no longer be used as a specific appellation. F. gentilis.

I have next to consider the Goshawk or *Falco palumbarius* of LINNÆUS. This species is very widely distributed. They breed in Scotland and the Orkney Isles, and have been observed in Spain, France, Germany, Switzerland, and the North of Italy. They are common in Denmark, Norway, Russia, and Siberia, particularly about Lake Baikal. Among the Uralian Mountains, they are said to be white, mottled with brown and yellow, and a somewhat similar variety is found in Chinese Tartary. In Kamtsckatka, the most abundant variety is nearly of an immaculate white; and these white birds, according to PENNANT, are the most esteemed in falconry. From Chinese and Indian paintings, we learn, that the Goshawk is known in the warmest regions of Asia; and judging from a drawing, which I had an opportunity of examining, the individuals found in India are darker in their plumage than the common variety found in Europe. They are generally diffused over the Continent of North America, but whether they have been observed in Africa, I do not know. They abound in the *Azores*, and these islands, in F. palumbarius.

F. palumbarius.

the opinion of some authors, derive their name from this circumstance, as the word *Azor* signifies a Goshawk in the Spanish language.

Considerable confusion has arisen in ornithology, from the differeuces between the plumage of the young and old birds of this species. The former, as we have seen, has been described as a distinct species under the name of Falcon Gentle, and the latter has so seldom fallen into the hands of naturalists, in a state of complete maturity, that it does not seem to have been accurately described at all.

I am inclined to think, that this bird is exceedingly rare in England, if it is ever found at present in the southern division of the island. I should rather suppose it confined to the northern districts of Scotland. In the Western Isles, the name is sometimes improperly applied to the Ring-tail, (*Falco pygargus*), but I have no reason to suppose, that the true Goshawk occurs there.

The adult male Goshawk, measures in length rather more than one foot ten inches. Its bill is blue, tipped with black, and lead colour at the base. Cere greenish-yellow. Irides yellow. The top of the head, back of the neck, and all the upper parts of the body, are of a deep bluish-black, with a few darker coloured spots, and in some places slightly tinged with brown. On each side of the neck above the shoulder, there is a broken patch of white, and over each eye there

is a whitish line. The throat, breast, and belly, are white, with numerous transverse lines of a blackish colour. These markings commence from the base of the bill, and extend to the extremity of the feathers on the thighs. The tail is long and consists of alternate bars of black and blackish-brown, but so dark as not to be easily distinguished without near inspection. The legs are yellow, and the claws black. The wings do not reach nearly to the end of the tail. F. palumbarius.

The foregoing description, will be perceived to differ from that usually given of the Goshawk, which is said to be of a deep brown on the upper parts of the plumage, with the tail ash-coloured, barred with dusky. This is owing to the resemblance which the two sexes bear to each other when immature, and to the length of time which the male requires to attain his perfect plumage.

The first change which is observable, is in the markings of the under plumage, which, from being longitudinal, become transverse. The dark blue shades of the upper part of the plumage, are not acquired for several years; and the observations of naturalists on this species, seem to have been made before the male had undergone his second change. Except in as far as regards size, the male Goshawk, on a general view, bears a considerable resemblance to the Sparrow Hawk, (*Falco nisus.*)

F. palumbarius.

The female, as is usual in birds of this family, is larger than the male. Her plumage is browner above, and less regularly barred below. The markings on the breast and belly, are more longitudinally disposed. The tail is ash-coloured with dusky bars.

The individuals of both sexes in a state of immaturity, differ from the adults; but they bear a much nearer resemblance to the females than to the males.

The following is a description of the Goshawk in its early plumage: Bill lead colour, black at the tip. Cere and irides yellow. Crown of the head blackish-brown, edged with ferruginous. Sides and back of the neck similar, but more pale, and in some specimens marked with yellowish-white. The pale streak above the eye is nearly obselete. Sides of the head greyish-brown, minutely streaked with black. The whole upper parts of the plumage are brown, edged with ferruginous. Wing-coverts marked with pale brown or yellowish-white. Primary and secondary quill-feathers greyish-brown, obscurely barred with black; the latter bordered at their extremities with dirty white; under parts of the plumage yellowish-white, in some tinged with ferruginous; each feather being marked down its centre with an elongated blackish-brown spot.

These markings are minute, and numerous on the throat; they are fewer in number, larger and

more distinct on the breast and belly, and extend to the vent-feathers and under-coverts of the tail. The feathers on the thighs are like the ground-colour of the breast, and are marked on the centre with narrow arrow-shaped lines pointing upwards. The tail extends five or six inches beyond the extremity of the wings, and is alternately barred with black and ash-colour, the tip is nearly white; legs yellow; claws black. F. palumbarius.

This will be found to approximate so nearly to some of the descriptions which have been given of the *Gentle Falcon*, as perfectly to warrant the conclusion which has been drawn, that many birds described under that name, are the young of the Goshawk.

The next species whose history requires to be considered, is the *Common Falcon* *. F. communis.

* When I had the honour of presenting this paper to the Society, I was not aware that several of the observations which it contains had been anticipated in the work of a foreign naturalist, with whose writings I was at that time unacquainted. The publication to which I allude, is the *Gemeinnützige naturgeschichte Deutchlands*, von J. M. Beckstein. It does not appear to have been much consulted by the ornithologists of this country, nor are the remarks which it contains, in as far as I have had an opportunity of judging, familiar to the French writers. Through the kindness of Professor Jameson, I have recently been enabled to compare the remarks of Beckstein

F. communis.

This I have never been able to identify as a distinct species in any collection, either British or foreign, and though it may not at present be generally admitted, I have no hesitation in asserting, that it is not specifically distinct from the *Falco peregrinus* of GMELIN and LATHAM. They are similar in size, and the colour of the bill, cere, irides, and legs, is the same in both. Of the *Falco communis*, there are twelve varieties described, many of which shew distinctly the transition to the Peregrine Falcon, and have occasioned a contrariety of opinion concerning which species they ought to be referred to. I have seen individuals in which the characters of the Common and the Peregrine Falcons were combined in

on some of the species, whose history I have endeavoured to illustrate, with my own observations; and I find that in several instances, I have drawn conclusions similar to those of the German naturalist. On account of this circumstance, I at first felt inclined to exclude some of the following observations, but in so doing, I found that the remainder must necessarily be presented in a less intelligible form. I have therefore allowed the paper to remain as it was originally written, in the belief that it may not be the less acceptable in consequence of its agreement in some respects with the *Gemeinützige Naturgeschichte Deutchlands*, to such as have not had an opportunity of consulting that work; and to those who have, I trust that this explanation will be deemed sufficient.

I have added a few notes from BECKSTEIN and others, to point out those particulars in which we coincide or differ.

such a manner as to render it impossible, in the belief of their being distinct, to determine to which they should have been assigned, and the descriptions which have been given of the Common Falcon, approach so near to the Peregrine in one stage of its plumage, that I have no doubt it is merely the young of that bird. F. communis.

MONTAGU was latterly inclined to this opinion, and but for the scarcity of the falcon tribe in this country, and the inaccessible nature of their haunts, his belief would soon have been confirmed *.

* BECKSTEIN is of opinion, that the *F. communis* of GM. is a two year old *F. butco*, the Common Buzzard of this country, as they agree in size, form, colours, &c. It is very possible, that BRISSON, in whose works the numerous varieties of the Falcon seem to have originated, may have taken his description from the Common Buzzard. This is the more likely, as he certainly does not mention the dark patch on the cheek of the Falcon, although that character (which would decidedly prove it to be the young of the *F. peregrinus*) has crept into the descriptions of most of the later ornithologists. I therefore agree with that naturalist, in supposing that the *F. communis* of GM. is merely the *F. buteo* of LINN. BRISSON, from whom GMELIN borrowed, appears, in fact, to have taken his description from the bird figured by FRISCH as a Falcon, but which is in reality the Common Buzzard. Still, however, there can be no doubt that the Common Falcon as generally characterised, both in scientific works and books on falconry, if not by its external marks, at least by its habits, and acquirements in the sports of the field,

Those varieties which have been referred by one naturalist to the Common Falcon, and by another to the Peregrine Falcon, are the connecting links between the immature dress of the one, and the perfect plumage of the other, and a knowledge of this circumstance removes much of the obscurity in which the history of the falcon tribe has been enveloped.

The alterations which take place in the plumage of birds, like other changes in the animal economy, are not the result of chance, but are regulated by certain physical laws.

These, as applicable to the falcon tribe, though more complicated, and notwithstanding many seeming variations, are not less regular in their effects than they are in regard to other genera of birds.

The different individuals described by BRISSON and other naturalists, are not to be considered as accidental varieties, depending upon no fixed principle; on the contrary, many of them represent the regular changes which take place in the plu-

cannot be supposed to have originated in any variety of the *F. buteo.* The Buzzard is the most sluggish, cowardly, and inactive of all birds of prey, and the least fitted for the art of falconry. The Common Falcon, generally so called, to whatever species it may be traced, is undoubtedly derived from a long-winged or hunting hawk, and not from any of the short-winged species.

mage of these birds, and which are found to bear an exact relation to age or sex.

No doubt, great alterations are sometimes effected by external causes, particularly by the difference in the degrees of heat and cold. Thus, the prevailing colour of the Goshawk in Kamtschatka, is white, in Tartary brown and yellow, in Europe bluish-black, tinged with brown, and in India nearly black; but few individuals of the same species, and of similar age, either of the Goshawk, or any of its kindred species, will be found to differ from each other in the same country, notwithstanding the general belief of the great irregularity in the plumage of the tribe. The different varieties of the Falcon described by authors, are therefore not the effect of accident, but are referable to a particular age and sex of the individual, and to the country in which it has been bred.

Most hawks, whose plumage is barred or transversely marked in the adult state, are longitudinally spotted while immature, and there is no instance of any species, whose colouring on attaining maturity, is longitudinally disposed, being characterised in youth by transverse markings. The barred appearance of the plumage, is a sure sign of at least a considerable advance towards perfection, and the want of it in any individuals of a species which is known to be at any time

characterised by it, is as sure a proof of immaturity.

Attention to these general laws, will greatly facilitate our endeavours to illustrate the history of obscure species.

Assuming, therefore, the Peregrine Falcon to be the species to which most of the varieties of the Common Falcon should properly be referred, I shall proceed briefly to review these and some other varieties described in the works of BRISSON and others, in order to determine the relation which they respectively bear to the *Falco peregrinus* from which they are derived.

Before doing so, however, it will be necessary to give an exact description of the Peregrine Falcon in its adult state.

F. peregrinus. The bill is lead-coloured, tipped with black. Cere and irides yellow; the latter in some, dusky. Crown of the head, back of the neck, and whole upper plumage, bluish-black, or deep lead colour, darkest about the head. The back, scapulars, and greater and lesser wing-coverts, crossed by nearly imperceptible bars of black, and a few feathers on these parts tinged with ferruginous. Primary quill-feathers black; the inner webs tinged with brown and spotted with white; the secondaries rather paler, with a shade of cinereous, and pale edges. Throat and sides of the head, yellowish-white. *From the inner angle of each eye, pro-*

ceeds a broad black streak down the side of the head, in the form of mustachoes. This character is seldom so distinct in the female as in the male, and is scarcely perceptible in very young birds of either sex. The under parts are pale, with transverse blackish-brown bars. These markings commence on the lower part of the breast, and descend to the vent-feathers. The feathers on the sides and thighs are likewise crossed, and it is on these parts, when the bird begins to assume its perfect plumage, that the transverse markings are first discernible. The throat is pure. The upper part of the breast is characterised by a few longitudinal streaks. Tail black, with numerous transverse cinereous bands, and yellowish-white at the tips. Legs yellow; claws black. The old and young birds bear the same relation to each other as those of the Goshawk. The old are transversely marked, the young longitudinally; and intermediate birds occur, with some parts transverse, some longitudinal. As the Sparrow Hawk may be said to represent the Goshawk in miniature, in like manner, the Hobby nearly resembles the Peregrine, before the latter has assumed the transverse markings. F. peregrinus.

In the Goshawk, the breast has a light bluish tinge, in the Peregrine a brownish one; and in the former, I have remarked, that the perfect plumage of the under parts is first acquired, but in the latter, the longitudinal spots on the breast

and belly may be observed for some time after the dark plumage of the back is completed.

F. hornotinus.

The *first* variety of the Peregrine Falcon, which I shall notice, is the Yearling Falcon; *Falco hornotinus* of BRISSON; *Le Faucon sors* of BUFFON. This is the young bird in its early plumage. It is of a lightish brown colour, with an ash-coloured tinge *.

F. (com.) fuscus.

The *second* variety, is the Brown Falcon; *Falco fuscus* of BRISSON.

The upper plumage is ferruginous-brown, with black streaks; beneath white, with brown spots. The young of the Peregrine Falcon occurs in this state in France and Switzerland. I should consider it as an immature female †.

* According to the German ornithologists, this is the yearling Peregrine Falcon. Indeed, it is quite obvious from BUFFON's plate of *Le Faucon sors*, (Enl. 470.)

† BUFFON considered the Faucon brun " moins un Faucon qu'un Buzard." CUVIER has adopted a similar opinion, and considers it synonimous with the Common Buzzard, *(La buse ordinaire.)*

The *F. (communis) fuscus* of GMELIN, according to BECKSTEIN, is a distinct species; it is the *F. fuscus* of the latter author. He is also of opinion, that the *F. fuscus* of BRISSON is probably the same as his *F. fuscus*, and consequently distinct from the *F. peregrinus*.

The *third* variety, is the White-headed Falcon; *Falco leucocephalus*, BRISS. F. (com.) leucocephalus.

I have never had an opportunity of examining any falcon which corresponds with the description given of this bird. It cannot be considered, like most of the others, as forming a link in the gradations of plumage from the yearling Falcon to the adult Peregrine. In contradistinction, therefore, to such as present the regu-

BECKSTEIN says in regard to the *F. fuscus*, that he at one time agreed with BUFFON in considering it as a variety of *F. buteo*, but was induced, from the observations of BECKER, and those of sportsmen, to consider it as a distinct species. In this opinion, he was probably confirmed by his belief that the Peregrine Falcon may in every stage of its plumage be distinguished by the dark feathers on the side of the head.

I have, however, good reason for believing, that that distinction, particularly in immature females, cannot always be relied upon, and should therefore be unwilling to constitute the *F. (communis) fuscus* a separate species, unless it can be shewn from other causes than the occurrence of an individual wanting some of those characters which usually distinguish the Peregrine Falcon, that they are really distinct.

At all events, I would rather incline to the opinion of BUFFON and CUVIER, that it is referable to the *F. buteo*, which would be more in the spirit of BECKSTEIN's own opinion regarding the *F. communis*, GM. to which the *F. fuscus* appears to be nearly allied.

F. (com.) leucocephalus. lar changes, I should term it an *accidental* variety *.

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* In the opinion of BECKSTEIN, the *White-headed Falcon* is specifically the same as the *F. lagopus* of GMELIN, the *Rough-legged Falcon* of the British Zoology, (App.) To the same species, Dr SHAW refers the *Dusky Falcon* of the Arctic Zoology, and MONTAGU thinks it probable, that the *Booted Falcon*, the *Falco pennatus* of BRISSON, upon future investigation, will also be found synonimous with the *F. lagopus*. I have examined several specimens of the Rough-legged Falcon, but they varied so much in colour, that I am still ignorant of the fixed state of plumage in that species. I have, however, little doubt, that PENNANT's Dusky Falcon is in reality one of its varieties. Whether BECKSTEIN's opinion concerning the *F. (communis) leucocephalus* be correct or not, can only be determined by the examination of a suite of specimens. With regard to the other supposed variety, the *F. pennatus*, I may observe that it is only known to naturalists from the description of BRISSON. Its native country seems quite unknown. The *F. lagopus*, from which I do not believe it to be distinct, is found in Denmark, Norway, and the Alps of Switzerland. Its geographical distribution, however, will be greatly extended, if, as LATHAM supposes, (*2d Supplement*, p. 24. No. 14.) it is synonimous with *La Buse Gantée* of VAILLANT, a species met with in the country about the Cape of Good Hope, particularly in the Forest of Hottinquas. This last mentioned variety, according to LATHAM, has a less mixture of white in its plumage; a circumstance which we are naturally led to expect from the difference of its physical position.

BUFFON was of opinion, that the *F. leucocephalus*, BRISS. was a variety of his Common Falcon. As the latter species is

Allied to the preceding, is the *fourth* variety, the White Falcon; *Falco albus*, Briss. It is white, with minute yellow spots. Some are immaculate, with the extremities of the greater quill-feathers blackish. F. (com.) albus.

Buffon is of opinion, that every white bird

synonimous with the Peregrine Falcon, the opinion expressed in the text, is in conformity with that of the French naturalist.

Having recently, however, considered the descriptions of this bird, and the opinions of Beckstein and Cuvier, I feel inclined to adopt their ideas, and view it as distinct from any variety of the *F. peregrinus*. Its characteristic distinction consists in the legs being feathered to the toes.

The specific name adopted by Cuvier, is *La Buse patue (F. pennatus)*, from which it appears that he considers it synonimous with the *Booted Falcon* of Latham. I have no doubt that it is described in ornithological works under many denominations, though I cannot at present venture to give the synonyms. The following extract from the "Regne Animal" of Cuvier, shews the opinion of that naturalist concerning the confused and intricate state of the species: "Cette buse (the *Buse patue*) est quatre fois dans Gmelin, sans y être jamais à sa place. C'est le *Falco lagopus*, Brit. Zool. App. t. 1.; le *Falco communis δ leucephalus*, Frisch. 75.; le *Falco pennatus*, Briss. App. pl. 1.; le *Falco Sancti-Johannis*, Arct. Zool. pl. ix."

I may add, that Beckstein considers the *Sclavonian Falcon* as synonimous with the *Falco lagopus*. Indeed, Dr Latham had previously suspected that it might prove a variety of that species. The German ornithologist is of opinion, that the *F. pennatus* is also a variety of the *Falco lagopus*.

F. (com.) albus. of this genus is a variety, and not a distinct species*.

* Under this head, ornithologists have arranged white varieties of the *F. peregrinus* and the *F. palumbarius*. In the opinion of BECKSTEIN, the *F. albus* of BRISSON, (*F. communis albus*, GM.) is a variety of *F. peregrinus*. CUVIER, on the other hand, considers it as synonimous with BUFFON's *L'oiseau Saint-Martin*, (erroneously described and figured in the *Histoire des Oiseaux* as a distinct species), and by consequence the same as the *F. pygargus* and *F. cyaneus*, the *Ring-tail* and *Hen Harrier* of our ornithologists.

CUVIER seems impressed with a deep sense of GMELIN's inaccuracies, and not without reason. But he appears to proceed rather too far in his opposition to that author's species. Thus, he not only refers the *F. communis albus* to the Ring-tail (*La Soubuse, F. pygargus*), but also the *F. montanus* B, the *F. griseus*, and the *F. bohemicus*. I shall not insist on the differences in plumage, as characters drawn from colour are not to be depended on. But there are such essential distinctions between the three last mentioned species themselves, that it is scarcely possible they should all be referable to the same species.

Thus, from the description of the *Grey Falcon* shot in Yorkshire, we learn that it is as large as a raven; its legs long, naked, and yellow.

The *F. bohemicus* is said scarcely to exceed a foot in length, and the legs are thickish and feathered below the knees.

The *F. montanus* B bears a considerable resemblance both in size and plumage to the male Ring-tail, but differs greatly from the preceding species. It is one foot nine inches in length, and is the only one of the three supposed varieties which I

The *fifth* variety, is the bird which has been described as a distinct species under the name of Common Falcon *. Common Falcon.

The prevailing colour of the plumage is brown, edged with ferruginous. The tail is transversely barred with shades of light and dark brown. The bill is blue; cere, irides and legs yellow. *On each cheek, a large brown patch or spot* †.

should feel inclined to refer to the *F. pygargus.* BECKSTEIN is of opinion, that it is an old male of that species.

With regard to the Grey Falcon, I may remark, that MONTAGU was informed by an experienced German falconer, that it is the *Tercel* or male of the *Ger-falcon* in its first plumage.

BECKSTEIN seems inclined to consider it as a distinct species, and thinks it is painted in the Gallery of Tenneberg at Walterhausen.

* I must again refer to the distinction which I suppose to exist between the Common Falcon usually so termed, as described and characterised by many of the French and English ornithologists, and in books on the art of falconry, and the individual whose description has been given in the works of BRISSON, GMELIN, &c. The former is undoubtedly the young of the Peregrine Falcon, the latter may be considered as synonimous with the *F. buteo* of LINN.

† The last mentioned character does not occur in BRISSON. This has probably induced BECKSTEIN to adopt the opinion before mentioned, that the *F. communis* is a two year old *F. buteo.* CUVIER describes the Common Falcon as follows: " Grand comme une poule, se reconnaît *toujours* à une sorte de *tache*

Common Falcon.

This bird has long been considered as the type or proper representative of the numerous varieties of the Falcon. That it is merely the Peregrine Falcon in a state of immaturity, I have already attempted to prove, and I am convinced that no doubt can be entertained on the subject by any person who takes the trouble of comparing the varieties * which follow with those which have been enumerated †.

triangulaire noire qu'il a sur la joue," &c. If the above description could be relied upon as uniformly applicable to the Common Falcon in every state of plumage, it might be adduced as a strong proof of the accuracy of BECKSTEIN's opinion regarding the *F. communis* of GM. and would induce me to refer the *F. fuscus* to the Common Buzzard. I have, however, seen a specimen of falcon which I have no doubt was the female of *F. communis*, (the *F. peregrinus* in a state of immaturity), on which the black patch had not become perceptible.

* It will be observed, that I have altered the order in which the varieties I am now considering have hitherto been placed. This is necessary, in order to illustrate more clearly the opinion I am anxious to establish, and to exhibit at one view the gradual transition from the state of immaturity to the plumage of the adult bird.

† In CUVIER's new work, published since this paper was written, I find that his opinion is similar to the one expressed above. I cannot, however, see the propriety of retaining the

The Common Falcon itself, is one of the first varieties in which we perceive an approach to the Common Falcon.

name of *Falco communis*, which does not in any ornithological work apply to the species in a state of maturity, and has by some authors been applied to a bird which does not belong to the falcon tribe. It is besides, necessarily associated with so many vague and contradictory descriptions of ill-defined species, that if used as a specific name, it will long continue to be the source of error and confusion. The specific name of *F. peregrinus*, on the contrary, is not liable to any such objection. The species has been well and clearly defined, and has never been confounded with any other species, except indeed by means of such of its immature varieties, as have been included under the unfortunate title of *Falco communis*. Besides, the assumption of such a title as that of *F. communis*, Gm. by Cuvier, is in contradiction even to his own opinion. It will be seen by referring to his late work, (*Regne Animal*, Note p. 310.) that, when stating his opinion in regard to the inaccuracies of Gmelin respecting the Common Falcon, he observes, that the variety *α* Frisch, 74. should be considered not as a Falcon but a Buzzard. Now, this variety *α*, is in fact the very *F. communis* which he has adopted as the representative of a species which he considers is synonimous with the *F. peregrinus* and all its varieties.

I trust that enough has been said to shew the propriety of the name of *F. communis* being no longer used as a specific appellation; and that consequently the title of *F. peregrinus* should be retained, to designate the species which has always borne that name, as well as such immature varieties as had been referred to another species, but which recent observations have proved are not really distinct.

Common Falcon. adult bird. This is obvious in the large brown patch or spot on the cheek, which in the mature Peregrine becomes black, and forms a distinguishing character. It may be considered as that bird after having passed at least one moulting.

F. gibbosus. The *sixth* variety, is the Haggard Falcon; *Falco gibbosus*, Briss.; *Le Faucon Hagard ou Bossu*, Buff.

This bird differs from the preceding, in being darker and more advanced in its plumage. It has been erroneously described as an aged bird, but the markings of its plumage prove the contrary. It assumes the hunch-backed appearance, not from age, but on account of its being about to cast its feathers. This I have observed in other hawks during the moulting season. As has been already observed, the term *Haggard* was not originally applied solely to this or any other variety or species, but to such hawks as were reclaimed from a state of nature after leaving the eyrie.

F. rubeus. The *seventh* variety, is the Red Falcon; *Falco rubeus*, Briss.

It is similar to the Common Falcon in its plumage, with this difference, that the feathers of the wings, instead of being marked with white, are spotted with red and black.

The *eighth* variety, is the Red Indian Falcon; *Falco ruber Indicus*, BRISS.* F. ruber Indicus.

From the description given by BRISSON, the male appears greatly to resemble the adult Peregrine Falcon of Europe. The upper parts of the plumage are nearly black; of the female cinereous brown.

The *ninth* variety, is the Spotted-winged Falcon; *Falco maculatus*, BRISS. F. (com.) maculatus.

This bird shews plainly, the transition to the adult Peregrine Falcon †. The upper plumage is brown; the rump and tail cinereous, with transverse black bars; and BRISSON observes, " In utroque capitis latere majuscula, est *macula longitudinalis nigra*, infra oculos orta, et ad colli exortum usque protensa;" and again, " Alæ, suprà lineis *transversis*, nigricantibus variegatæ." LATHAM enumerates this among the varieties of the Common Falcon; but he seems to have been aware of its relation to the Peregrine Falcon, as it is again given as a variety of that species, and the same synonyms are referred to. BUFFON considered it as the young of the following variety.

* The *F. ruber Indicus* is conjectured by BECKSTEIN to be a distinct species. The same opinion was adopted by BUFFON.

† I find that BECKSTEIN also considers it as the Peregrine Falcon.

F. niger. The *tenth* variety, is the Black Falcon; *Falco niger*, Briss.

This differs so much from the bird described under the name of Common Falcon, that although generally given as one of its varieties, Buffon considered it as a distinct species; and indeed it would have been difficult to believe otherwise, supposing, as Buffon and all the ornithologists of his time did, that the *Falco communis* and *Falco peregrinus* were specifically distinct *.

Latham follows Brisson, and gives the Black Falcon as a variety of the Common Falcon, but in his Supplement he hints at the probability of its being a variety of the Peregrine. He says it

* This is the true *Faucon Pelerin ou Passager* of Buffon, considered by him as distinct from the Common Falcon, and in a state of complete maturity. It is figured in the *Histoire des Oiseaux*, under the name of *Le Faucon noir et Passager*, (Enl. 469.)

I have endeavoured to shew, that it is the *F. peregrinus* approaching to maturity, and not distinct from the Common Falcon of Buffon.

Beckstein says it is the two year old Peregrine Falcon, which is just the age I should have assigned it from an inspection of the plumage.

I am happy to find that Cuvier also considers it an immature variety of the Peregrine Falcon, (now the *Faucon ordinaire* of the French.) He observes, " Ceux qu'on appelle Faucons pelarins, Enl. 469. paraissent des jeunes un peu plus noirs que les autres."

is a larger bird; but this may be accounted for on the supposition of his specimen being from America, where both the Peregrine and Goshawk are larger than in Europe. EDWARDS supposes that this and the last mentioned variety, are male and female, and form a species of themselves. F. niger.

This confusion no doubt arises from authors having described the Common and Peregrine Falcons as distinct. The two last varieties combining in a certain degree the characters of both, have occasioned, like some others, a difficulty regarding the species to which they should have been referred; but all variance of opinion is reconciled by considering the Common Falcon as merely the young of the *Falco peregrinus*.

I have seen a specimen of the latter from North America, which agrees in every respect with the Black Falcon, except in the colour of the legs, which were yellow instead of blue. I may here remark, that the colour of the legs is not to be constantly relied upon as a specific character. I have seen the Peregrine Falcon with greenish legs, and one out of three taken from the same nest, was observed by MONTAGU to have the legs of a bluish-grey colour*. The upper plumage of the

* It is well known that the colour of the irides and legs of birds is subject to change, and that individuals of the same species are not always characterised by a similarity of colour in those parts. In addition to what I have stated in the text in

F. niger. Black Falcon, is of a deep blackish-brown. It approaches nearer to the adult bird than any of

proof of this fact, I may add the following extracts. Buffon, when describing the *Balbuzzard*, observes, " Il a les jambes nues et ordinairement de couleur bleuâtre; cependant il y en a quelques-uns qui ont les jambes et les pieds jaunâtres." In another place, he adds on the same subject, " Ce charactère est donc beaucoup moins fixe qu'on ne l'imaginoit," &c. (*Hist. des Ois.* pp. 82. & 213.); and Cuvier, under the article *Gerfault*, remarks, " Les pieds et la membrane du bec sont tantôt jaunes, tantôt bleus." (*Regne Animal*, p. 313.)

I have been the more circumstantial in this matter, as some ornithologists have maintained that the colour of the cere, irides, and legs, is invariable in the same species; in which case, the *F. niger*, as described by Brisson, could not be assigned to the Peregrine Falcon. On again referring to the *Synopsis Methodica* of Brisson, I feel inclined to suppose, that the individual therein described under the name of *F. niger*, was about to experience a change in the colour of the legs, by which it would have been even more closely allied to the Peregrine Falcon.

In regard to the variety in question, I believe I shall be able to trace in a sufficiently satisfactory manner, some important changes to which it is liable, by which means I shall obviate any objection which might be urged against its being considered as synonimous with the Peregrine Falcon. On comparing the different descriptions of the *F. niger*, I find that there is a singular gradation in the colour of the legs, by which the furthest removed varieties are connected by means of an intermediate link, with such as approach most closely to the ordinary Peregrine Falcon.

Thus, in the account given by Buffon of *Le Faucon noir*, it is remarked, " Nous observerons que cet oiseau que nous avons eu en nature, avoit le pieds d'un *bleu bien décidé*," &c. (*Hist. des Ois.* p. 213.) Brisson, in his description of the same spe-

the other varieties, and is distinguished by the F. niger.
mature plumage of the head : " In utroque capitis

cies, observes, " Pedes sunt *plumbeo-viridescentes ;* prope digitos magis ad *flavum* inclinant," (*Syn. Meth.* p. 95.) EDWARDS describes it with the legs of a "*greenish-lead colour*" inclining to yellow; and, according to BUFFON, it is described and figured by FRISCH with the legs of a *yellow colour,* as in the generality of falcons.

The preceding quotations, it will be observed, are conclusive in regard to the *variation* in the external characters of the *F. niger ;* and the descriptions by BRISSON and EDWARDS, when taken in conjunction with the other two, demonstrate the probability of a *change* sometimes taking place in the same individual, as the birds described by EDWARDS, and in the *Synopsis Methodica,* appear to have been intermediate between BUFFON's and FRISCH's, or, as it were, losing the blue tinge, and acquiring the yellow one. This circumstance is interesting, both in a general view, as connected with the physiology of birds, and as illustrative of those variations, a knowledge of which is necessary to enable us to ascertain with tolerable certainty the distinctions between individuals exhibiting accustomed or accidental changes, and such as may be considered as peculiar and permanent varieties, and in assisting us to determine the species to which particular varieties ought to be referred.

The colour of the legs in the *F. niger,* therefore, cannot be considered as forming in any degree a specific distinction between it and the Peregrine Falcon. There is probably in different individuals, either a transition in colour from blue to yellow, as I suppose to have been exemplified in the four birds described by BUFFON, BRISSON, EDWARDS, and FRISCH, or the distinction is permanent, and may be considered to result from that peculiarity in the constitution of the bird, which produces the variation in the shade and markings of the plumage.

F. niger. latere *macula* est *nigra*, ab oris angulis procedens, et deorsum tendens, *mystacis instar*." It has not assumed the transverse markings of the lower plumage, but is spotted longitudinally; and this agrees with the observation which I formerly made, that the upper plumage of the Peregrine Falcon is first completed, although in the Goshawk the transverse lines on the breast are observable before the darker shades of the back are acquired.

It will be seen from the preceding varieties, that there is just ground for believing, that the opinion which I have adopted is correct. By presenting them in the order in which they have been arranged, the gradations in plumage are distinctly perceived; and there is little room left to doubt, that the common Falcon and the Peregrine Falcon are the same. Many more varieties have been described, but those enumerated are sufficient to illustrate the subject, and the others, being for the most part merely *accidental*, have been purposely omitted.

F. tartaricus. F. barbarus. To the same species may be referred the *Falco tartaricus* of BRISSON; and it is probable that the *Falco barbarus* of LINNÆUS is also either the young, or an accidental variety of the Peregrine Falcon *.

* With regard to the *F. tartaricus*, BECKSTEIN has formed the same opinion. Both BECKSTEIN and CUVIER consider the *F. barbarus* as the young of the Peregrine Falcon.

I trust that the few observations which I have made, may be of use in calling the attention of others to the study of a tribe of birds, whose history is the most obscure and problematical within the range of ornithological science.

I am now of opinion that the *F. barbarus* and *F. tartaricus*, are the same variety. BUFFON seems to have considered them as such, and in the old work before mentioned, there is the following passage: "The *Barbary*, or, as some call her, the *Tartaret Falcon*, is a bird seldom found in any country, and is called a passenger, as well as the Haggard." "They are called Barbary Falcons because they make their passage through that country and Tunis, where they are more frequently taken than in any other place, namely, in the Isles of the Levant, Candy, Cyprus and Rhodes." (*Gentleman's Recreation*, p. 124.)

To the other varieties of the Common Falcon, CUVIER has added the *F. stellaris* of GM.

XXXV. *On the Geognosy of the Lothians.*

By Professor JAMESON.

(Read 17th December 1814.)

FEW districts in Scotland afford greater variety of mineralogical phenomena than the Lothians; and in none of them are the various transitions, junctions and alternations, of the beds and strata, and crossings of the veins, more distinctly and satisfactorily exhibited. In this beautiful tract of country, the rocks are those of the transition, flœtz, and alluvial classes, and of these the flœtz formations are the most interesting and important, from the numerous and unexpected relations which they display, and the various useful minerals they contain. Red sandstone occurs in such quantity, as to form an important feature in the geognosy of these counties, but the coal formation is that which most powerfully excites our attention.

I.—ON THE RED SANDSTONE AND COAL FORMATION IN THE MIDDLE DISTRICT OF SCOTLAND.

In order to render our description of the Lothians satisfactory, it will be useful to premise a

short general account of the Red Sandstone and Coal Formations, as they occur in the Middle District of Scotland, to the north of the Frith of Forth *.

Red Sandstone.

1. *Red Sandstone.* This deposite forms several tracts of country in the middle district of Scotland; and of these, the most extensive is that to which we shall at present confine our attention It stretches from Stonehaven in Kincardineshire, to the west side of the Island of Arran, in the Frith of Clyde; and it varies in breadth from a few fathoms to many miles. In some places, as in Kincardineshire, it forms extensive flats or plains, whilst in others, it rises into hills, or ranges of hills; and of these latter, the most extensive and highest are the Ochil and Seadly ranges, some of whose summits are 2000 feet above the level of the sea. On the coasts of Kincardineshire and Angusshire, and also on the shores of Arran, it forms striking sea-beat precipices; or is hollowed into caves of great grandeur and magnificence.

* The Middle District of Scotland, is that bounded on the south by the Frith of Forth, and on the north by the line of the Caledonian Canal.

It is also intersected and broken by the violence of the waves; and the continued action of the waters of the ocean, has carried away enormous portions of it, forming in its stead bays of greater or less extent.

These bays do not appear to be always on the increase; on the contrary, they seem in general to have limits set to their progress. After a longer or shorter period, depending on the nature of the rocks, their positions in regard to the sea, and their relations to the other bays and promontories on the coast, they begin to be filled up with alluvial matter, which, in the course of time, extends outwards to the furthest promontories, and even beyond them; and thus, again, secures the land, for a time, from the destroying effects of the ocean.

There are hollows in the surface of this sandstone tract, which are filled with water, thus forming lakes; and everywhere we observe it traversed by rivers and rivulets, which either follow the direction of natural rents, or original inequalities of the sandstone, or have worn their way through it. In the lower parts of the river districts, in particular, there are beautiful displays of alluvial terraces; but I have not met with any of these high up on the sides of the valleys *.

* It may here be noticed, that alluvial terraces occur frequently in the course of rivers, not only where they pass through

Mineralogists, in general, distinguish two red sandstone formations; one, the oldest, rests immediately on transition or primitive rocks; the other, and newer, rests on beds of magnesian limestone, coal, and mountain limestone, which are superimposed on the oldest formation. The mountain limestone, in a general view, may be considered as a transition limestone, contained in the lower part of the red sandstone formation, and bearing the same relation to it, that the beds of red sandstone in the upper part of the transition series do to grey-wacke. The coal and magnesian limestone are frequently wanting, and then the two red sandstone formations come to rest upon each other. When the sandstone formations are thus arranged, it is difficult to distinguish the one from the other. It may be that they are both only portions of the same great red sandstone formation, and that the coal and magnesian limestone are but subordinate members, that may or may not occur in it, without affecting the general characters of the deposit as a great formation in the series of mountain rocks. In illustration of this conjecture, it may be stated, that in some extensive red sandstone di-

alluvial tracts, but also in rocky and mountainous situations, where they flow through valleys, or expand into lakes. These terraces, whether they appear on the banks of lakes, or high up on the sides of valleys, or in low alluvial flats, are to be viewed as the effects of water seeking a lower level, whether suddenly or slowly.

stricts, the trap and porphyry rocks occupy three-fourths of the whole mass; yet these rocks may be wanting without their absence affecting the general characters of the red sandstone formation. In the same manner, the various subordinate beds in the clay-slate, such as whet-slate, drawing-slate, and alum-slate, may be wanting, and still the characters of the clay-slate, as a distinct formation, remain.

In several places on the sea coast, as near the mouth of the North Esk, and in the tract extending from Montrose to Lunan Bay, where the subordinate trap and porphyry rocks prevail, there are striking rugged sea cliffs.

The red sandstone rests on Primitive rocks, or on rocks of the Transition class. It is distinctly stratified, and the strata vary from the horizontal to the nearly perpendicular position. The strata are sometimes waved, but are more frequently straight. Sometimes vertical strata are to be seen meeting others which are in a horizontal position, and occasionally vertical strata appear to be contained in great masses of nearly horizontal or slightly inclined strata. Occasionally the strata in a small district appear disposed in every possible position; and at first sight suggest to us the idea either of great original inequalities, or of violent action on the strata after their formation, but which, upon more careful examination and consideration, would seem rather to intimate that

the whole mass of strata is in its original position, and composed of a series of distinct concretions, in each of which, the layers or apparent strata vary more or less in position, in these respects resembling what we observe in greenstone, porphyry, and other similar rocks.

Enormously thick but short beds of sandstone, are sometimes surrounded with thin strata of sandstone, slate-clay, and other rocks. It occasionally happens, that in a ravine or valley, the one side will present a vertical face of red sandstone, without any marks of stratification, thus intimating the presence of a thick massive bed, while the opposite side will exhibit numerous thin beds of sandstone and slate-clay, dipping towards the mural precipice. Here all the rocks are in their original position; there has been no sinking of strata on the side with the mural precipice; for, the thin strata, if continued to the precipice, would either rise toward it, or terminate suddenly upon it without any change in their direction, just as we observe to be the case with the thin sandstone strata, where they come in contact with thick beds of the same rock. Many of the pretended sinkings and shifts enumerated and described by geologists, are of this description. Indeed it would appear, that these mechanical actions are much less frequent than has been generally imagined, and that the crust

of the earth is more firmly built than is admitted by some speculators.

The strata sometimes rest on the primitive or transition rocks in a conformable position, or they are unconformably disposed; for in some extensive tracts, the primitive and transition rocks dip to the S. E., while the superimposed strata of red sandstone, dip to the S. W. The sandstone is generally composed of roundish and angular grains of quartz and felspar, with scales of mica. These are either connected together by a basis of iron-clay, ironshot slate-clay, which is occasionally marly, quartz, or calcareous matter, or no perceptible basis or ground is to be detected. When the common basis or connecting material of the grains is awanting, then the sandstone has much of the aspect of a crystallised rock, and we can observe portions of the grains of quartz and felspar, and of the scales of mica shooting into each other in the same manner as occurs in granite, gneiss, and other crystallised rocks.

Some varieties of the sandstone might be mistaken for grey-wacke: indeed, so strong is the resemblance, that even experienced mineralogists have occasionally committed the error of describing as grey-wacke varieties of red sandstone. But this error will always be avoided, if we recollect, that formations are to be distinguished by the characters of the rocks as they occur on the great scale, and not from such accidental va-

rieties of appearance as are sometimes exhibited in hand specimens. Cotemporaneous veins of a granitous rock, of the same general character with the sandstone, sometimes traverse it; in other instances, cotemporaneous veins of quartz, or of felspar, also occur in the sandstone *.

When the basis of the sandstone increases in quantity, the sandstone gradually passes into slate-clay, or into iron-clay, quartz, or limestone, according to the nature of the basis or ground. The iron-clay is often amygdaloidal, so that there is then a transition from the sandstone into amygdaloid. Many veins of sandstone are to be observed shooting from the sandstone rock into the amygdaloid and other similar rocks, and portions of sandstone imbedded in beds of trap and porphyry, send out veins or branches from all sides. In other instances, portions of amygdaloid are imbedded in the sandstone, and either intermixed with the sandstone at the line of junction, and gradually pass into it, or they send out branches into the inclosing sandstone. But this is not all the variety of appearances presented by the sandstone.

* Rocks having the same structure and general appearance as red sandstone, appear occasionally in transition, and also in primitive districts, as in countries abounding in clay-slate and gneiss,—a fact which at first sight appears inconsistent with the general distribution and arrangement of the different rock formations.

The individual strata have sometimes a slaty structure, and this structure is generally parallel with the direction of the stratum, but sometimes it is at right angles to it. It is either straight slaty, or undulating slaty, and the layers are sometimes disposed in a concentric manner, and thus the stratum appears composed of a congeries of balls or globular concretions. Some beds of sandstone have a conglomerated or brecciated aspect, the rock appearing to be composed of blunt and sharp angular fragments set in a basis of sandstone. But these are merely apparent fragments, and are to be considered as varieties of structure of the sandstone, probably produced by the process of crystallisation. The careful and connected study of these conglomerated appearances as they occur in sandstone, limestone, quartz, granite, gneiss, clay-slate, and other rocks, leads to very important and interesting conclusions.

The sandstone contains many different rocks in beds or veins. The most important of these are the following: *Conglomerate*, *slate-clay*, *claystone*, *clay-ironstone*, *trap-tuff*, *amygdaloid*, *basalt?* *clinkstone*, *felspar*, *porphyry*, *greenstone*, *pitchstone*, *limestone and limestone-conglomerate*, and *coal* *.

* The occurrence of trap rocks in red sandstone, is stated in the Mineralogy of the Scottish Isles, which I published in 1801.

1. *Conglomerate.* This rock, which is composed of roundish, and sometimes angular masses of various kinds and sizes, imbedded in a basis or ground, occurs in beds varying in thickness from a few feet to several hundred yards. It is distinctly stratified, and the strata, although generally horizontal, yet are occasionally much inclined, even sometimes nearly vertical. The beds of conglomerate are generally conformable with those of the red sandstone, and sometimes unconformable, the nearly horizontal beds of conglomerate resting upon pretty highly inclined strata of sandstone, and these horizontal beds being again covered with inclined strata of sandstone. It alternates with, and frequently passes into, the red sandstone. Sometimes, small granular conglomerate is contained in the coarse, in the form of roundish balls or concretions, from three to five feet in diameter. These remarkable concretions at first sight, might be confounded with the rounded balls of granite, which are imbedded in the conglomerate.

The roundish and angular masses of which the conglomerate is chiefly composed, vary in size from that of a few inches to several yards in diameter. They are of different rocks and minerals. Thus, at *Crawtown*, a few miles from Stonehaven, *porphyry* is the predominating imbedded rock, and is associated with granite, gneiss, quartz, &c. At *Bervie*, the most abundant masses are of quartz

and *porphyry*, associated with masses of granite, containing garnets, syenite, gneiss, mica-slate, clay-slate, hornblende rock, hornblende-slate, *amygdaloid*, jasper, and *red sandstone*. Of these substances, the amygdaloid, sandstone, and in general the porphyries, *are of the same species with those which occur in beds and veins in the great red sandstone formation*. At the *Bridge of Prosen*, the conglomerate contains principally masses of *porphyry* and *amygdaloid*, with pieces of quartz. At *Blairgowrie*, where there are stupenduous rocks of conglomerate, the most frequent imbedded masses, are *porphyry* and *amygdaloid*, with quartz and mica-slate. Near *Comrie*, they are principally *porphyry* and *amygdaloid*. At *Callender*, the imbedded masses are chiefly *porphyry* and *amygdaloid*; and in Arran, the conglomerate contain masses of *porphyry* and *trap*. These masses are usually connected together by a basis or ground of smaller grains of the same rocks and minerals. Sometimes the imbedded porphyry and amygdaloid is intermixed with the cement at their line of junction, and we observe branches shooting from them into the basis or ground.

2. *Slate-clay*. This rock occurs in the sandstone, and also in the conglomerate, in beds that vary in thickness from a few inches to several fathoms. Its most general colour is reddish-brown, and

sometimes a greyish-black. The red-coloured variety is oftentimes variegated with stripes, layers, and circular portions of a green colour. Some varieties of this rock are so highly impregnated with carbonate of lime, that they may be considered as impure kinds of slaty marl. It passes into claystone, and sometimes also into clay-ironstone.

3. *Claystone.* This mineral occurs in beds that vary in thickness from an inch to several yards. It alternates with slate-clay, and also with red sandstone, and with some other rocks which are subordinate to that formation.

4. *Clay-ironstone.* It occurs in layers, or in irregular or globular-shaped masses, generally included in slate-clay. A beautiful transition is to be observed from the slate-clay into the ironstone: at one extremity of the series is the pure slate-clay, at the other the perfect clay-ironstone; and the middle part of the series, is a substance intermediate between the slate-clay and the ironstone. It follows from this fact, that all the phenomena exhibited by the clay-ironstone, such as globular forms, cotemporaneous veins, &c. are of the same general nature with those of the slate-clay, and that if slate-clay owes its characters to deposition from a state of aqueous solution, the same must have

been the case with the ironstone. It is a frequent mineral in several red sandstone districts.

5. *Trap-tuff.* This remarkable rock occurs in beds, often of a great thickness, in red sandstone. It passes not only into claystone, but also into the red sandstone. It is by no means an uncommon rock in some of the red sandstone districts in the tract of country we are now describing.

6. *Amygdaloid.* This rock contains many different minerals, either in its vesicular cavities, or imbedded in it. These are calcareous-spar, steatite, quartz, agate, zeolite, and felspar. It occurs in beds, and also in veins: the beds vary in thickness from a few feet to many fathoms. It is frequently traversed by veins of sandstone; and beds of sandstone and also conglomerate, many hundred feet in extent, and of considerable thickness, occur in the cliffs of amygdaloid in different parts of this district. Cotemporaneous masses of amygdaloid occur imbedded in the sandstone. It passes into trap-tuff, and also into sandstone.

7. *Basalt.* A rock having several of the characters of basalt, occurs, in beds and veins, in the red sandstone.

8. *Clinkstone.* This beautiful rock occurs, in beds and veins, in the red sandstone.

9. *Compact Felspar.* Compact felspar, generally of a red colour, and often passing into claystone, occurs in beds in this red sandstone district.

10. *Porphyry.* This interesting and beautiful rock occurs in considerable abundance in beds and veins in the red sandstone and conglomerate. Claystone, ironstone, and felspar-porphyries, are those met with in this tract. There are sometimes amygdaloidal, and occasionally the crystals of felspar, are wanting, when beds or veins of claystone or felspar appear in place of the characteristic porphyry. The claystone-porphyry appears to pass into claystone,—this into sandstone. Sometimes the porphyry is conglomerated, and then it sometimes contains imbedded balls of granite, and angular pieces of hornblende rock and clay-slate.

11. *Greenstone.* This rock occurs in beds, imbedded masses, mountain masses, and veins, in the red sandstone and conglomerate.

12. *Pitchstone.* Green and black-coloured varieties of this rock, are met with in the form of imbedded masses, beds and veins, in red sandstone.

13. *Limestone and Limestone-Conglomerate.* Extensive beds of these rocks occur in the red sandstone; and beautiful transitions from the limestone into the surrounding sandstone and trap, are not of rare occurrence.

14. *Coal.* Several species of this important mineral occur in the red sandstone, as glance-coal, slate-coal, and pitch-coal. They are generally disposed in beds, more rarely in imbedded masses and veins.

From the short description just given, it is evident, that the Red Sandstone Formation is much more interesting than has been generally imagined. The great variety and abundance of porphyry and trap rocks contained in it, their transitions into each other, and into sandstone, limestone and clay, are very striking facts in their natural history, and deserving the particular attention of those who take an interest in the volcanic and neptunian theories of their formation. Those naturalists who are inclined to think favourably of the opinion which maintains the chemical forma-

tion of sandstone, will adduce the various kinds of structure exhibited by the red sandstone, as so many facts illustrative of its plausibility, and the miner and engineer, if they adopt this opinion, will probably obtain an easy solution of difficulties that occur in their respective arts, and practical rules of value and importance to them.

APPENDIX.

HISTORY

OF THE

SOCIETY.

THE first meeting of the Society for public business took place on the 2d March 1808, in the College Museum, when Professor JAMESON read a paper on Cotemporaneous Veins. This paper is inserted in the First Volume of the Memoirs, p. 1.—7. 1808. March 2. Professor Jameson on Cotemporaneous Veins.

Professor JAMESON read some observations on the colouring Geognostical Maps. This paper is inserted in the First Volume of the Memoirs, p. 149.—161. He also laid before the Society a series of Mineralogical Queries. These Queries are inserted in the First Volume of the Memoirs, p. 107.—125. 1808. April 9. Professor Jameson on Geognostical Maps, and Mineralogical Queries.

1808. May 14. Professor Jameson, Mineralogical Queries; Mr Walker's List of Birds in the neighbourhood of Edinburgh.

Professor JAMESON finished the reading of his Mineralogical Queries, illustrating them by remarks. Mr WALKER then laid before the Society a List of Birds found in the Neighbourhood of Edinburgh, with observations on the rare or disputed Species.

1808. June 11. Captain Laskey on Pinna ingens. Dr Anderson on Inchkeith. Dr Thomson on Fluor-spar.

Captain LASKEY read a paper on the Pinna ingens. This paper is inserted in the First Volume of the Memoirs, p. 102.—106. Dr CHARLES ANDERSON then laid before the Society a general sketch of the Geognosy of the Island of Inchkeith, in the Frith of Forth, as preparatory to a more detailed account. Dr THOMSON read a paper on Fluor-Spar, which is published in the First Volume of the Memoirs, p. 8.—11.

1808. July 16. Mr Neill's List of Fishes.

Mr NEILL laid before the Society a List of such Fishes as he had ascertained to be natives of the waters in the neighbourhood of Edinburgh, accompanied with specimens of the rarer species. This list is contained in the First Volume of the Memoirs, p. *526.—555.* Two communications from Colonel Montagu were then read; one of them upon the characters and habits of the Gannet, Pelecanus Bassanus, and the distribution of the Air-Cells in that Bird; the other describing a new Insect, found in the Cellular Membrane of the Gannet. These papers are

Colonel Montague's Observations on the Gannet, and Description of a new Insect.

inserted in the First Volume of the Memoirs, p. 176.—200.

1808. August 1. Dr Ogilby on the Geognosy of East Lothian.

Dr JAMES OGILBY laid before the Society an interesting view of the Geognosy of East Lothian, illustrated by an extensive series of specimens, arranged according to their Geognostic position.

1808. Nov. 12. Rev. A. Jameson on Meteorological Tables, and descriptive of a new Anemometer; and Mr Fleming's Account of the Rocks of Unst and Papa Stour.

A paper of the Reverend Mr A. JAMESON, on Meteorological Tables, and description of a new Anemometer, was read. Then a paper by the Reverend Mr John Fleming, containing an account of the Geognostic relations of the rocks of the Islands of Unst and Papa Stour, which contained answers to the President's queries concerning the Serpentine and Sandstone of Shetland. The Mineralogical account of Papa Stour is inserted in Volume First of the Memoirs, p. 162.—175.

1808. Nov. 19. Mr Mackenzie on Coal Formation of Durham.

Dr Ogilby on Veins in Flœtz-trap Rocks.

There was read a Communication by Mr MACKENZIE, younger of Applecross, containing an account of the Coal Formation in the Vicinity of Durham. This paper is inserted in the First Volume of Memoirs, p. 605.—608. At the same meeting, Dr OGILBY read observations on the Veins of the Flœtz-Trap Rocks of East Lothian, being a continuation of his description of that country, which is inserted in the First Volume of

Mr Neill on the great Sea Snake.

Memoirs, p. 469. And Mr NEILL read an account, compiled from documents sent from the Orkneys, of a singular Animal, of great size, and corresponding to the description given by EGEDE and PONTOPPIDAN, of the Great Sea Snake of the Northern Ocean.

1808. Dec. 10. Mr Fleming's Description of the Narwall. Dr Ogilby's Account of the Rocks of Fassney.

There was read a description by the Reverend Mr FLEMING, of a Small-headed Narwal, cast ashore in Zetland. This description is inserted in Volume First of Memoirs, p. 131.—148. And Dr OGILBY read the conclusion of his Mineralogical description of East Lothian, which contained an account of the Rocks of Fassney, which is inserted in Volume First of Memoirs, p. 126.—130.

1809. Jan. 14. Dr Thomson's Analysis of Copper-glance. Dr Barclay's Remarks on the Animal of Stronsa.

Dr THOMSON read a description and Analysis of a variety of Copper-Glance from North America. Dr BARCLAY communicated to the Society remarks on some parts of the Animal that was cast ashore on the Island of Stronsa in September 1808. These remarks are inserted in the First Volume of Memoirs, p. 418.—444.

1809. Feb. 11. Professor Jameson on Cryolite.

Professor JAMESON read an account of the Oryctognostic characters and Geognostic relations of the Cryolite from West Greenland. This paper is inserted in First Volume of Memoirs, p. 465.—468. Three communications were then

laid before the Society. 1. A singular instance of the intrepidity of the Common Otter in defending its young, by Captain LASKEY. 2. An account of an Animal resembling a Toad, found imbedded in a stratum of Clay in Govan Colliery, by Mr DIXON of Govan Hill, communicated by Mr RUSSELL. 3. A copy of the affidavits made before the Justices of the Peace at Kirkwall, concerning the Great Sea Animal of Stronsa, accompanied with remarks. These affidavits are printed in First Volume of Memoirs, p. 431. Mr NEILL read some account of a Fin-Whale stranded near Alloa. This account is inserted in First Volume of Memoirs, p. 201.—214.

Captain Laskey on the Otter.

Mr Russel's communication respecting a Toad found in Clay.

Affidavits in regard to the Sea-Snake.

Mr Neill's Description of a Fin Whale.

The Secretary read Colonel MONTAGU's account of a non-descript Fish, named by him Ziphotheca tetradens, and descriptions of four rare species of English Fishes taken on the Coast of Devonshire. These descriptions are inserted in 1st vol. Mem. p. 79.—101. Captain LASKEY laid before the Society an ample Catalogue of North British Shells, with remarks on the new and rare species. This Catalogue is inserted in 1st vol. Mem. p. 370.—417. And Dr YULE read observations on Monocotyledonous Plants, and on the natural order Gramineæ.

1809. March 11. Colonel Montagu's Description of some rare and new English Fishes.

Captain Laskey's List of British Shells.

Dr Yule on Monocotyledonous Plants.

The first part of a description of the Coal Formation of Alloa, by Mr BALD, was read by

1809. April 8. 1st Part of

Mr Bald's Description of the Coal Field of Alloa.
Mr Stewart's List of Insects found near Edinburgh.

the Secretary. Mr STEWART then laid before the Society a list of Insects found by him in the neighbourhood of Edinburgh, with introductory remarks. This list is inserted in 1st vol. Mem. p. 566.—577.

1809. May 13. Rev. Mr Fleming's enumeration of the Plants of West Lothian.
Mr Walker on Eels.
Continuation of Mr Bald's paper on the Coal Formation of Alloa.
Letter concerning the Sea Snake.
Mr Don's List of Plants in the King's Park.

The Reverend Mr FLEMING laid before the Society an outline of the Flora of West Lothian, enumerating only such Plants as are omitted by LIGHTFOOT, or marked as uncommon by Dr SMITH. Mr WALKER read an account of some Eels which had lived for fourteen years in a subterraneous pool at Drumsheugh. The Secretary read the continuation of Mr BALD's description of the Coal Field of Alloa. Likewise a letter from the Reverend DONALD MACLEAN of Small Isles, describing the appearance of a Great Sea Snake, or marine animal of some sort, among the Hebrides in June 1808. And a communication from Mr GEORGE DON of Forfar, containing a list of Plants growing in the King's Park, but not included in Mr YALDEN's list published at the end of the Flora Scotica.

1809. Nov. 4. Mr Brown on the order Asclepiadeæ.

The Secretary laid before the Society a learned Botanical paper from R. BROWN, Esq. F.R.S. on the Asclepiadeæ, a natural order of Plants separated from the Apocineæ of JUSSIEU. This important Memoir is inserted in the 1st vol. Mem.

p. 12.—78. The first part of an essay on Meteoric Stones, by Mr G. S. HAMILTON, was then read.

Mr Hamilton on Meteoric Stones.

1809. Dec. 9.

Professor JAMESON laid before the Society a list, with remarks, of Marine Vermes found by him in the Frith of Forth, and other parts of Scotland. This list is inserted in 1st vol. Mem. p. *556.—565.* Professor JAMESON then laid before the Society a fine collection of Topazes, lately found in the Highlands of Aberdeenshire, with remarks on their probable Geognostic relations. These remarks are inserted in 1st vol. Mem. p. 445. And the Secretary presented to the Society an ample Catalogue of the rare Plants to be found in the course of a day's excursion from Edinburgh, communicated by Mr ROBERT MAUGHAN *senior*. This paper is inserted in the 1st volume of the Memoirs, p. 215.—248.

Professor Jameson's List of Vermes found in Scotland.

Professor Jameson on the Topaz of Scotland.

Mr Maughan's Catalogue of rare Plants near Edinburgh

1810. Jan. 13.

The Secretary laid before the Society a Communication from Mr WILLIAM SCORESBY of Whitby, comprising a Meteorological Journal of several Voyages to Greenland, and an account of different Crystallisations of Snow observed there. The Journals are published in 1st vol. Mem. p. 249.—257. The Reverend Dr Macknight then read a Mineralogical description of Ben-Ledi and the neighbourhood, illustrated by a series of specimens of the different rocks.

Mr Scoresby's Meteorological Tables, and description of Crystallisations of Snow.

Dr Macknight's Mineralogy of Ben-Ledi.

1810. Feb. 3. Dr Macknight's Mineralogy of Ben-More and Glencoe. Professor Jameson on the Strontian Lead-glance Formation.

The Reverend Dr MACKNIGHT read a Mineralogical description of the Mountain of Ben-More, and the Valley of Glencoe, which he illustrated by specimens. These descriptions are inserted in 1st vol. Mem. p. 294.—318. Professor JAMESON exhibited some specimens said to have been found near Dunkeld in Perthshire, from which he thought it probable that the Galena or Lead-Glance Formation of Strontian, might be expected in that neighbourhood. The paper on the Strontian Lead-Glance Formation, inserted in the 1st vol. Mem. p. 461., contains the observations then laid before the Society. The Secretary read a Journal kept by Mr SCORESBY of Whitby, of a Voyage to Lat. 81° 12′ 42″ N., along with some curious remarks on the Common Whale; and he exhibited an original drawing of that Animal, presented to the Society by Mr SCORESBY. Mr SCORESBY's account of the Whale, is inserted in 1st vol. Mem. p. 578.—586.

Mr Scoresby's Voyage to lat. 81° 12′ 42″ N.

Mr Scoresby's description of the common Greenland Whale.

1810. March 10. Dr Macnight's mineralogy of Ben-Nevis and Strontian. Dr Edmonston's Natural History of Zetland Sheep.

Dr MACKNIGHT read a continuation of his Mineralogical tour to the Highlands of Scotland, embracing a description of Ben-Nevis and Strontian. These descriptions are inserted in 1st vol. Mem. p. 319.—357. Dr EDMONSTONE read observations on the natural and medical history of the Zetland Sheep. This Memoir is inserted in 1st vol. Mem. p. 258.—273. The Secretary then read com-

munications from Lieutenant-Colonel IMRIE, and from Captain LASKEY; the former mentioning the occurrence of Greenstone in Glencoe in the form of Veins; und the latter containing some observations on the Lepas dilata. Colonel Imrie on the Greenstone vein of Glencoe. Captain Laskey on Lepas dilata.

Dr MACKNIGHT read a continuation of his account of the Highlands, embracing the country from Ben-Lawers, through Glen Tilt and Braemar. This paper is inserted in 1st vol. Mem. p. 358.—369. The Secretary read a communication from Colonel IMRIE, on the Conglomerate Rock, which stretches along the south front of the Grampians. This communication is inserted in 1st vol. Mem. p. 453.—460. There was then read the third and last part of Mr BALD's account of the Coal Formation of Clackmananshire. This paper is published in 1st vol. Mem. p. 479.—503. 1810. April 9. Dr Macnight's mineralogy of Glen Tilt and Braemar. Colonel Imrie on the Conglomerate of the Grampians. 3d Part of Mr Bald's Coal Formation of Clackmananshire.

The Reverend Mr FLEMING read an account of several Marine Animals found by him in Shetland. Dr BARCLAY read some remarks on parts of the structure of the Animal cast on shore in Stronsa last year, shewing that it could not be a Squalus maximus, as supposed by Sir EVERARD HOME. 1810. May 19. Rev. Mr Fleming on the Marine Animals of Zetland. Dr Barclay on the Animal cast on shore at Stronsa.

The Secretary read a communication from WILLIAM FITTON, Esq. on the Porcelain-earth 1810. May 26. Dr Fitton

on the Porcelain-earth of Cornwall. Dr Yule on the Germination of the Gramineæ.

of Cornwall; and Dr YULE read a paper on the Germination of the Gramineæ, illustrating his remarks by specimens and drawings. Dr YULE's paper is inserted in 1st vol. Mem, p. 587.—604.

1810. July 21. Mr Campbell on the Antilunar Tide. Dr Thomson on Gaseous combination of Hydrogen and Carbon.

Mr CAMPBELL of Carbrook read some observations on the cause of the Antilunar or Inferior Tide, impugning the Newtonian theory on that subject; and Dr THOMSON read a paper on the Gaseous Combinations of Hydrogen and Carbon. Dr THOMSON's paper is inserted in 1st vol. Mem. p. *504.—525.*

1810. Nov. 24. Colonel Montagu's communication. Mr Mackenzie's Analysis of Compact Felspar. Mr Scoresby's Greenland Journal, 1810.

The Secretary read an additional communication on the Fasciola trachea, and on the Ziphotheca tetradens, from Colonel MONTAGU; and an account of the Analysis of the Compact Felspar of the Pentland Hills, by CHARLES MACKENZIE, Esq.; and he laid before the Society a Meteorological Journal of a Greenland Voyage performed this year, by Mr WILLIAM SCORESBY *junior.*

1811. Jan. 12. Professor Jameson's Geognostic descripiton of Arran.

Professor JAMESON read the first part of a Geognostical description of the Island of Arran, illustrated by numerous specimens. The Secretary laid before the Society a Meteorological

Journal kept at Clepham House, Hudson's Bay, for 1808 and 1809, by Mr PETER FIDLER, communicated by WILLIAM AULD, Esq. Fidler's Meteorological Journal.

Professor JAMESON read the second part of his Geognostical description of the Island of Arran, illustrating it by sketches and specimens. 1811. Feb. 2. Second Part of Professor Jameson's Account of Arran.

Professor JAMESON read an account of the Pentland Hills, illustrating his description by sketches and specimens. This paper is inserted in 2d vol. Mem. p. 178.—201. 1811. Feb. 16. Professor Jameson on the mineralogy of the Pentland Hills.

The Secretary read a communication from Dr THOMSON, containing an Analysis of an Iron-Ore from Greenland; also a communication from Dr EDMONSTONE of Lerwick in Shetland, on the Larus glaucus; and from Dr BARCLAY, on the Cells of Bees and Wasps. Dr THOMSON's communication is inserted in 2d vol. Mem. p. 51.—57. Dr BARCLAY's in 2d vol. Mem. p. 259. 1811. Mar. 9. Dr Thomson's Analysis of Iron-ore from Greenland. Dr Edmonstone on the Larus glaucus. Dr Barclay on the Cells of Bees.

Mr WILLIAM ELFORD LEACH read an account of the natural tribe of Diptera, called Eproboscidea by LATREILLE, with descriptions of the species, which he illustrated by drawings and specimens. At the same meeting, Professor JAMESON gave an account of the occurrence of Coal in Red Sandstone, in several districts on the Con- 1811. April 6. Mr W. E. Leach's Account of Eproboscidea. Professor Jameson's Account of Coal in Red Sandstone.

tinent of Europe, from whence he inferred the possibility of Coal existing in a similar situation in Scotland.

1811. April 27. Professor Jameson on Iceland Crystal. Mr Ellis on the Wind of a Ball. Dr Edmonstone on the Ember Goose. Dr Gordon on Sound, and the musical Ear.

Professor JAMESON read a paper on the Geognostical Situation of that variety of Calcareous-spar found in Iceland, and named Iceland-spar. A paper from Mr D. ELLIS was then read, shewing that the effects of what is called the Wind of a Ball, depend on an accumulation of the electric fluid. The Secretary next read some remarks by Dr EDMONSTONE on the Colymbus immer, or Ember Goose. This paper is inserted in 2d vol. Mem. p. 232.—237. And Dr GORDON read a paper, consisting of Observations and Experiments on the Qualities of the Sensations of Sound; on the different modes in which sonorous vibrations are communicated to the auditory nerve; on the ideas of the distance, and of the angular position of the sounding bodies with respect to the ear, which are associated by experience, with the different qualities of sounds; and on some of the more remarkable differences in the sense of hearing, both original and accidental, which are occasionally observed among individuals, and particularly on the Musical Ear.

1811. July 27. Mr Mackenzie on Hemp from Plantain Tree.

Mr MACKENZIE read a paper on manufacturing Hemp from the Plantain Tree cultivated in the West Indies. And the Secretary read a Description by Mr LEACH of a Sword-fish caught in the

Frith of Forth. This description is inserted in 2d vol. Mem. p. 58.—60.

Mr Leach's Description of a Sword Fish.

The Secretary read a communication from Dr EDMONSTONE, entitled, Observations on the Larus parasiticus. Professor JAMESON then gave a short Description of some specimens of Syenite from Galloway, containing Zircon and Sphene.

1811. Nov. 16. Dr Edmonstone on the Larus parasiticus. Professor Jameson on Syenite from Galloway.

The Secretary read a communication from the Reverend Mr FLEMING, describing a Bed of Fossil Shells which occurs near Borrowstounness; and the Description of a new species of Echinus, observed by Mr LEACH in Bantry Bay, and which he proposed to call E. lithophagus. Professor JAMESON read a series of Observations on the Geognostical relations and Formation of Granite; and also Observations on the mode to be followed in describing Petrifactions, which he illustrated by the description of an undescribed camerated fossil shell from Sicily. The description was accompanied by a set of very highly finished drawings.

1811. Nov. 30. Mr Fleming on a bed of Fossil Shells. Mr Leach's description of a new Echinus. Professor Jameson on Granite, and on the mode of describing Fossil Organic remains.

The Secretary read the description of a new Craniometer proposed by Mr LEACH. Likewise a series of Thermometrical Observations on the Temperature of the Gulf Stream, communicated

1811. Dec. 14. Mr Leach's Craniometer. Dr Manson on Gulf Stream.

Professor Jameson on the Geognosy of the Stewartry of Kirkcudbright.

by Dr MANSON. Professor JAMESON then read a General Account of the Geognosy of the Stewartry of Kirkcudbright, and exhibited specimens of the different species of rocks.

1812. Jan. 18. Mr Leach's description of two new species of Shark.

Mr LEACH read a description of two species of Shark, as illustrative of a proposed subdivision of the genus Squalus of LINNÆUS. He likewise communicated an Analysis of the Bones of the Orkney Animal, by Mr JOHN DAVY. This paper is inserted in the 2d vol. Mem. p. 61.—66. Professor JAMESON read a paper on Porphyry. This paper is inserted in vol. ii. p. 217.—220. of Memoirs.

Professor Jameson on Porphyry.

1812. Feb. 1. Col. Imrie on Geology of the Campsie Hills.

The Secretary read a communication from Colonel IMRIE on the Geology of the Campsie Hills. This paper is inserted in the 2d vol. Mem. p. 24.—58.

1812. Feb. 22. Mr Macgregor's Mineralogy of Lanark. Mr Scoresby's Meteorological Journal in Greenland for 1811. Mr Huey's notice of a Sea Snake.

The Secretary read a communication from Mr JOHN MACGREGOR, Surgeon to the 25th Regiment, describing the Mineralogy of the country around Lanark, illustrated by specimens and sketches. Professor JAMESON read extracts from a Meteorological Journal kept by Mr SCORESBY *junior* in Greenland, in 1811, which is inserted in vol. ii. Mem. p. 155.—166.: also a Note from Lieutenant ALEXANDER HUEY of the 73d Regiment, describing the appearance of a large Sea Snake in the Antarctic Ocean, accompanied with a sketch. He

then read a Mineralogical Account of the Rocks near Dundee, communicated by Mr FLEMING, which is published in 2d vol. of Mem. p. 138.—144. Mr Fleming's description of the Rocks of Dundee.

1812. Mar. 7. Col. Montagu on Sponges. Dr Yule, natural method. Native Copper.

The Secretary read an Essay on British Sponges, by Colonel MONTAGU, which is inserted in 2d vol. Mem. p. 67.—122.; and Dr YULE read Observations on the Natural Method in Botany. Professor JAMESON exhibited specimens of Native Copper and of Red Copper-ore from Unst in Shetland.

1812. March 28. Mr Aitken's Meteorological Observations. Professor Jameson's Mineralogical Observations. Dr Leach's description of the Orkney Pig.

The Secretary presented a Journal by Mr JOHN AITKEN, surgeon, containing a Thermometrical Register and Meteorological Journal from Newcastle to Davis Straits, and back again, communicated by Dr BARCLAY. Professor JAMESON gave an account of a Flœtz Serpentine which occurs in Fifeshire; also of the occurrence of Basalt and Quartz rock in the coal formation of that country; and of Fibrous Gypsum in Berwickshire, illustrating his remarks by specimens. Dr LEACH read a description of the Pig of Orkney and Shetland, which he considered as a distinct species, and named Sus borealis.

1812. April 11. Dr Macknight's description of Tinto.

Dr MACKNIGHT read a Mineralogical Description of Tinto Hill in Lanarkshire, illustrating his account by specimens and sketches: this paper

Governor Graham's Meteorological Observations in Hudson's Bay.

is inserted in vol. ii. Mem. p. 123.—137. The Secretary read extracts from a Meteorological Register kept in Hudson's Bay by Governor GRAHAM.

1812. May 16. Dr Yule's Account of a new Alloy. Dr Leach on the class Insecta.

Dr YULE read an account of a New Alloy employed for the making of Types in the East Indies; and he also read a continuation of his Botanical Observations. The Secretary communicated to the Society some Observations on the class Insecta of LINNÆUS, by Dr LEACH.

1812. Nov. 14. Mr Mackenzie's description of the Ochil Hills.

Professor JAMESON read a Description of the Ochil Hills, communicated by CHARLES MACKENZIE, Esq. and which is inserted in vol. ii. Mem. p. 1.—23. The description was accompanied with a series of specimens, and a map of the district.

1812. Dec. 5. Mr Fleming on Silver Mines at Bathgate. Professor Jameson on the distribution of Carbon.

The Secretary read a description of the Sorex fodiens, and of the Old Silver Mines in the Bathgate Hills, by the Reverend Mr FLEMING. Professor JAMESON read a paper on the Distribution of Carbon in the Mineral Kingdom.

1813. Jan. 16. Mr Scoresby's Greenland Journal for 1812.

The Secretary read a communication from Mr SCORESBY, containing his Greenland Journal for 1812, with some curious particulars concerning some Greenland animals, especially the Polar Bear. At the same meeting, Professor JAMESON read a

paper on Formations, general and partial, and more particularly on those described by CUVIER and BRONGNIART as occurring around Paris.

Professor Jameson on Formations.

1813. Feb. 16.

The secretary read a communication from Mr SYME, shewing the advantages of a double or enlarged Bee-hive; and also a paper from the Reverend Mr FLEMING, describing the rocks near St Andrew's. This last is inserted in 2d vol. Mem. p. 145.—154. Professor JAMESON read a paper on the Arrangement of Simple Minerals.

Mr Syme on Bee-hives. Mr Fleming on Rocks around St Andrew's. Professor Jameson on simple Minerals.

1813. March 13.

Dr MACKNIGHT read a Lithological Account of the Environs of Loch Lomond, and illustrated his description with specimens of the rocks and simple minerals. This paper is inserted in 2d vol. Mem. p. 392.—403.

Dr Macknight's Account of Loch Lomond.

1813. April 17.

The Secretary read a paper from JAMES HOY, Esq. Gordon Castle, describing a species of Trichiurus lately cast ashore near Fochabers. Professor JAMESON read a series of Observations on Granite Veins; and also a communication from the Reverend Dr GRIERSON.

Professor Jameson on Granite Veins.

Communication from Dr Grierson.

1813. Nov. 20.

The Secretary read an account of an Analysis of Pearl-spar, received from Professor HISINGER, dated Köping in Sweden. The paper is inserted in 2d vol. Mem. p. 174.—177.

Professor Hisinger on Pearl-spar.

1813. Dec. 4. Professor Jameson on Conglomerated Rocks. Captain Brown's List of Shells.

Professor JAMESON read a paper on Conglomerated Rocks, which is inserted in 2d vol. Mem. p. 202.—216.; and the Secretary read extracts from Captain BROWN's List of the Shells of the coast of Northumberland.

1814. Jan. 8. Captain Laskey's Account of Fossil Shells. Professor Jameson on Stratification, &c.

The Secretary read a letter from Captain LASKEY, giving an account of a Bed of Shells laid open in the course of digging out the new Canal between Ardrossan and Paisley. Professor JAMESON then read a paper on the Stratification of Rocks; the nature of Veins, and the origin of Coal. This paper is inserted in 2d vol. Mem. p. 221.—231.

1814. Jan. 21. Professor Jameson's Mineralogy of Burntisland.

Professor JAMESON read a particular account of the Geognostical relations of the Strata, Beds, and Veins, that occur in the Parish of Burntisland in Fifeshire.

1814. Feb. 12. Dr Macknight on the Cartland Craigs, near Lanark. Dr Thomson on new Lead-Ore.

Dr MACKNIGHT read an account of the Cartland Craigs near Lanark, illustrating his description by specimens. The Secretary read a description and Analysis of a new species of Lead-Ore from India, by Dr THOMSON; and exhibited a specimen from Millburn Tower of the flower of an Acacia, which had never before flowered in this country.

Professor JAMESON read a paper by the Reverend Dr GRIERSON, on the Dee Granite District in Galloway, which was illustrated by specimens and sketches.

1814. March 5. Dr Grierson on the Dee Granite.

The Secretary read a communication from the Reverend Mr FLEMING on the different species of Mus found in Scotland; likewise an account by Mr W. BULLOCK, of various rare Birds which he had observed in the north of Scotland, and Orkney and Shetland Islands. Then Professor JAMESON read the first part of his description of the Geognostical Structure of the Country at the Needle's Eye in Galloway.

1814. April 16. Mr Fleming on the genus Mus.

Professor Jameson on the Geognosy of the Needle's Eye.

The Secretary read a description by Dr FLEMING, of ten species of the genus Orthocera, illustrated by drawings. He also read Mr HUGHS's Note of the Strata cut through at the Coal-Pit of Brora in Sutherland, transmitted by Mr DEMPSTER of Dunnichen. Likewise an account by Mr NICOL, Lecturer on Natural Philosophy, of a Flœtz-Limestone possessed of flexibility, which he discovered near Tynemouth Castle in the county of Durham, of which fine specimens were exhibited. There were also laid before the Society Meteorological Journals kept during Voyages to Davis Straits during the years 1813 and 1814, by Mr WILLIAM SCORESBY *junior* of Whitby.

1814. Nov. 12. Dr Fleming's description of Orthocera. Section of Brora coal-pit.

Mr Nicol's account of the discovery of Flexible Limestone.

Mr Scoresby's Meteorological observations in Davis's Straits.

1814. Dec. 3. Captain Brown's description of new Shells. M. Gieseke's descriptions of new and rare Greenland minerals. Dr Yule on the Asplenium Ruta-muraria.

The Secretary read a communication from Captain BROWN, describing five new species of Shells, observed by him in Ireland, illustrated with drawings, and giving a list of the Shells found by him in Dublin Bay. Then Professor JAMESON read Mr GIESEKE's descriptions of some rare and new Minerals observed by him in Greenland. Dr YULE gave an account of his having succeeded in raising from the seed, one of the smallest of the British Ferns, the Asplenuim ruta-muraria of LINNÆUS.

1814. Dec. 17. Letter from Mr Scott regarding the junction of Transition and Flœtz rocks. Professor Jameson on the mineralogy of the South of Scotland. Mr Miller on Flexible Sandstone from Ayrshire. Mr Scoresby on the nature of Polar Ice.

Professor JAMESON read a letter from Mr SCOTT at Ormiston, describing the junction of the Transition and Flœtz Rocks near Jedburgh, and mentioning the occurrence of Granite in Roxburghshire. Professor JAMESON then read the first part of his observations on the Mineralogy of the Southern Division of Scotland, including a general account of the Flœtz Formations in the Middle Division of Scotland, and a particular description of the Rocks which occur on the coast of East Lothian. Specimens of Red Sandstone were presented by Mr MILLER *junior*, from Barskimming in Ayrshire, which, when cut into long thin bars, possess a degree of flexibility, the flexibility being considerably increased when the stone is wetted. The Secretary then read the first part of Mr SCORESBY's paper on the nature of the Polar Ice.

The Secretary read the continuation of Mr SCORESBY's account of the Polar-Ice. Then a description of some remarkable Atmospheric Appearances observed during a Thunder Storm on the 29th of July last, by Mr P. SYME, with beautiful sketches. Professor JAMESON continued his account of the Mineralogy of East Lothian. Mr CHARLES WHITLOW from America, exhibited specimens of a new species of Urtica, found by him in Upper Canada, which affords a fibre, considered to be superior to that of hemp.

1815. Jan. 21. Mr Scoresby on Polar Ice. Mr Syme on a remarkable meteoric appearance. Professor Jameson on the mineralogy of East Lothian. Mr Whitlow on a new species of Urtica.

The Secretary read a communication from Dr YULE, on the germination and physical economy of Ferns; and also the first part of a paper by Dr FLEMING, on the Mineralogy of the Redhead,

1815. Feb. 4. Dr Yule on Ferns. Dr Fleming on the Red Head.

The conclusion of Dr FLEMING's account of the Redhead, was read, and illustrated by specimens. Professor JAMESON read a short account of the Geographical and Physical distribution of the Fossil remains of Animals of the Elephant tribe, and exhibited a mammoth's tooth, discovered by Mr AULD during his residence in Hudson's Bay, this being the first time such remains have been observed so far north in Ame-

1815. Feb. 25. Dr Fleming on the Red Head. Professor Jameson on the fossil remains of the Elephant; and of Mr Auld's discovery of the mammoth in Hudson's Bay.

Professor Jameson on the Talc of Unst.

rica. Professor JAMESON also read a notice concerning the Indurated Talc which occurs in quantity in the Island of Unst, one of the Zetlands, and which, he stated, might be profitably brought to market, the article being in demand for removing stains from silks, &c., and selling at a considerable price.

1815. March 11. Professor Jameson's mineralogy of East Lothian. Mr Scoresby on Polar Ice.

Professor JAMESON read a continuation of his Mineralogical Description of East Lothian, illustrating it by sketches and specimens. The Secretary read the continuation of Mr SCORESBY's paper on the Polar Ice.

1815. March 25. Mr Wilson's description of Aquatilis undulatus. Mr Scoresby's paper on Polar Ice concluded.

Mr WILSON read the description of a new species of Water Ouzel, named by him Aquatilis undulatus; and a specimen of the young bird, and a drawing of the bird in a state of maturity, were exhibited. The Secretary then read the concluding part of Mr SCORESBY's paper on the Polar Ice, with his remarks on the practicability of travelling to the North Pole. This paper is inserted in 2d vol. Mem. p. 261.—338.

1815. April 15. Mr Gilby on rocks of Bristol. Colonel Montagu on rare British Fishes.

The Secretary read a communication from Mr GILBY on the Rocks around Bristol. The first part of a paper by Colonel MONTAGU on some rare or new British Fishes, was then read.

The Secretary read the remainder of Colonel MONTAGU's paper on rare British Fishes; and also his account of a species of Delphinus, killed in the River Dart in Devonshire.

1815. May 20. Conclusion of Colonel Montagu's paper on Fishes.

The Secretary read a notice from Mr H. M. DACOSTA, regarding Native Iron from Leadhills. This notice is published in 2d vol. Mem. p. 370.—372. Also several descriptions of Shells, by Captain Brown.

1815. Nov. 25. Mr Dacosta on Native Iron. Captain Brown's description of Shells.

The Secretary read the description of an improved Rain Gauge, by Mr KERR.

1815. Dec. 16. Mr Kerr's Rain Gauge.

The Secretary read Dr MACKNIGHT's Mineralogical description of Ravensheugh; and Professor JAMESON communicated extracts of an interesting Letter from Dr MITCHELL of New-York.

1816. Jan. 6. Dr Macknight's on Ravensheugh. Dr Mitchell's letter.

The Secretary read a Mineralogical description of the country around Loch Doon in Ayrshire, by Dr GRIERSON, and the description was illustrated by an exhibition of specimens. Captain LASKEY presented a drawing of an uncommon Petrifaction, resembling an Actinia, found by him in sandstone.

1816. Jan. 20. Dr Grierson's description of Loch Doon. Captain Laskey's drawing of a petrifaction.

Mr CAMPBELL read the first part of his paper on the upright growth of Vegetables; and the

1816. Feb. 3. Mr Campbell on the

upright growth of plants. Mr Wilson on the Cirl Bunting.

Secretary read a communication from Mr WILSON, containing remarks on the characters of the Cirl Bunting, and announcing the fact of a specimen having been shot near Edinburgh; which specimen was presented.

1816. Feb. 17. Professor Jameson on the Fossil Elk of the Isle of Man.

Professor JAMESON read a series of observations on the extinct species of Cervus, and a communication concerning the skull and horns of an extinct species of Elk, found in the Isle of Man, differing in several respects from those of the Irish Elk; transmitted by Mr SCOTT, Receiver-General of that Island. Mr CAMPBELL of Carbrook read the second part of his paper on the upright growth of Vegetables; and the Secretary read a communication from Dr HOLDER on the inteneration of butcher-meat or poultry, by means of the juice or exhalation of the Carica papaya or Papaw-tree.

Mr Campbell on the upright growth of vegetables. Dr Holder on the inteneration of flesh by the juice of the papaw tree.

1816. Mar. 2. Professor Jameson on Lepidolite. Mr Stevenson on the bed of the German Ocean.

Professor JAMESON read a paper on the Lepidolite of Scotland; and the Secretary read the first part of Mr STEVENSON's paper on the probability of a change constantly going on in the level of the Bed of the German Ocean.

1816. Mar. 16. Dr Walker's account of his own studies.

Professor JAMESON read an account of Dr WALKER's Mineralogical Studies, and a description of his Collection, written by himself. The Secre-

tary then read a notice concerning a variety of the Common Rabbit, found in the Isle of May, remarkable for the length and silky fineness of its hair.

The Secretary read Dr Holder's communication concerning the fall of Volcanic Dust in Barbadoes in 1812; and also Dr Grierson's account of his visit to the Giant's Causeway, illustrated by specimens of the Rocks and Minerals. 1816. Mar. 16. Dr Holder on volcanic dust of Barbadoes. Dr Grierson on the Giant's Causeway.

The Secretary read an account of a Portable Boat contrived by Mr Bruce of the Naval Yard, Leith. 1816. April 15. Mr Bruce's portable boat.

At this meeting, no public business. 1816. June 8.

The Secretary read Dr Yule's communication on the utility of the Bark of the Larch-tree in tanning sole-leather, accompanied with specimens of the bark and leather. Dr Barclay afterwards read a communication on the Causes of Organization. This paper is published in 2d vol. Mem. p. 237.—246. 1816. June 22. Dr Yule on the bark of the Larch Tree. Dr Barclay on the causes of organisation.

The Secretary read a communication from Mr Dacosta, in regard to the Mineralogy of the Giant's Causeway. Professor Jameson read a communication, transmitted to him by Principal 1816. Nov. 23. Mr Dacosta's notice regarding the Giant's Causeway.

Lieutenant Webb's account of the great heights in India.

BAIRD, mentioning some very remarkable Heights in Northern India, ascertained by Lieutenant WEBB, in the service of the Honourable East India Company.

1816. Dec. 7. Mr Neill's description of the Beluga.

The Secretary read an account of the dimensions, and some of the external characters of the Beluga which was killed in the Frith of Forth in June 1815.

1816. Dec. 21. Dr Barclay's dissection of the Beluga.

Dr BARCLAY read an account of the dissection of the Beluga which was killed in the Frith of Forth in June 1815.

1817. Jan. 4. Dr Macknight's mineralogy of Cruachan.

Dr MACKNIGHT read the first part of an account of the Mineralogy of Ben-Cruachan, and of the country from thence towards Fort William.

1817. Jan. 18. Dr Macnight's mineralogy of Fort William and Cairngorm.

Dr MACKNIGHT read the remainder of his Mineralogical description of the country between Cruachan and Fort William, and towards Cairngorm.

1817. Feb. 1. Mr Wilson on the genus Falco. Professor Jameson on the country from Perth to Garviemore.

The Secretary read the first part of Mr WILSON's paper on the Genus Falco; and Professor JAMESON read an account of the Mineralogy of the country between Perth and Garviemore.

The Secretary read the remaining part of Mr WILSON's paper on the genus Falco of LINNÆUS. 1817. Feb. 15. Mr Wilson on the genus Falco.

The Secretary read a communication from Mr SCORESBY, on the effects of the pressure of the Waters of the Ocean at great depths; and Professor JAMESON gave an account of some remarkable geognostical appearances observed by him on the east coast of Scotland, particularly near to Montrose. 1817. March 1. Mr Scoresby on the Pressure at great Depths. Professor Jameson on the Geognosy of the east coast of Scotland.

Professor JAMESON continued his description of the Geognosy of the east coast of Scotland. 1817. March 15.

The Secretary read a communication from ALEXANDER STEWART, Esq. of Calcutta, mentioning the occurrence of the Tapir in the Malay Peninsula, accompanied with a reduced drawing of the animal, and a representation of the skull of the natural size. Professor JAMESON continued his account of the Geognosy of the east coast of Scotland. 1817. April 19. Mr Stewart on the occurrence of the Tapir in Malacca. Professor Jameson on the Geognosy of the east coast of Scotland.

Professor JAMESON continued his observations on the Geognosy of the east coast of Scotland. 1817. May 3.

1817. May 17. Communication from Mr Lauder Dick.

The Secretary read a communication from THOMAS LAUDER DICK, Esq. contained in a letter to Dr GORDON, giving an account of the transportation to some distance, by natural means, of a mass of rock, weighing about eight tons, situated near Castle Stewart in Inverness-shire.

1817. June 7. Communication regarding the remains of an Elephant found in Ayrshire. Communications from Mr Braid, surgeon, Leadhills.

The Secretary read a communication from Mr JOHN MACKENZIE at Irvine, addressed to Colonel FULLERTON, giving an account of some Fossil Bones, apparently those of an Elephant, found in tirring a sandstone quarry in Ayrshire; also two communications from Mr BRAID, surgeon at Leadhills, addressed to Dr CHARLES ANDERSON, Leith, the one describing a Thunder Storm which occurred on the 15th February 1817; and the other, giving an account of some curious effects of a noxious Gas on several persons exposed to it in the Mines.

1817. Nov. 15. The Society adjourn on account of the death of the Princess Charlotte of Wales.

The Society having met for the first time this Session, it was moved by Professor JAMESON, and unanimously agreed to, That in consequence of the melancholy event of the death of the Princess CHARLOTTE of WALES, the Society should immediately adjourn, without proceeding to business.

1817. Dec. 6. Mr Scoresby's account of Jan Mayen's Island.

Professor JAMESON read a communication from Mr SCORESBY, containing an account of his examination of the remote and desolate island, named Jan Mayen's Island, and which appeared to him to be principally composed of Volcanic Rocks, and those of the Flœtz-Trap Formation.

OFFICE-BEARERS, 1818.

Office-Bearers elected at the Meeting on the 6th December 1817.

President.

ROBERT JAMESON, Esq. Prof. Nat. Hist. Edin.

Vice-Presidents.

Colonel IMRIE.	JOHN CAMPBELL, Esq.
Lord GRAY.	Sir PATRICK WALKER.

Secretary, PAT. NEILL, Esq.
Treasurer, WILLIAM ELLIS, Esq.
Librarian, JAMES WILSON, Esq.
Painter, P. SYME, Esq.

Council.

Dr MACKNIGHT.	D. BRIDGES *jun.* Esq.
C. S. MENTEATH, Esq.	Dr D. RITCHIE.
Dr WRIGHT.	D. FALCONER, Esq.
Dr YULE.	T. SIVWRIGHT, Esq.

List of Members of the Wernerian Natural History Society of Edinburgh,—continued from the First Volume.

RESIDENT.

1811.

July 27. Mr Thomas Dickson, Leith Walk.

Dec. 24. The very Reverend George Baird, D. D. Principal of the University of Edinburgh.

1812.

April 11. Melville Burd, Esq.

James Wilson, Esq. Edinburgh.

May 16. Thomas Hopkirk *junior*, Esq.

Nov. 14. James Heriot, Esq. of Ramornie.

1813.

Mar. 13. The Right Honourable Lord Viscount Arbuthnot.

The Right Honourable Lord Gray.

Major-General Dice, Edinburgh.

1814.

Dec. 3. David Falconer, Esq. of Carlourie.

Walter Adam, Esq. Edinburgh.

1815.

Feb. 4. John Trail Urquhart, Esq. Advocate.

1816.

Jan. 20. Dr David Ritchie, Professor of Logic in the University of Edinburgh.

Dr William Somerville, Edinburgh.

1816.
March 2. ALEXANDER MILLER, Esq. of Rosebank.
30. ARTHUR NICOLSON, Esq. of Lochend.
Dec. 7. ALEXANDER ADIE, Esq. Edinburgh.
1817.
Jan. 4. THOMAS SIVWRIGHT, Esq. of Meggetland.
Mar. 15. G. ROBERTSON SCOTT, Esq. of Hedderwick.
May 3. Captain FREDERICK MARRYAT, R. N.
17. Colonel DAVID WILLIAMSON, Portobello.
Dec. 20. WILLIAM NEWBIGGING, Esq. Edinburgh.

NON-RESIDENT.

1811.
April 6. EDMUND LAMPLUGH IRTON, Esq.
Dr COLIN CHISHOLM.
Nov. 16. Colonel GEORGE AINSLIE, 26th Regiment.
30. SIMON WILKINS, Esq. Norwich.
1812.
Mar. 7. RICHARD RAWLINS, Esq. Dawlish.
Nov. 14. J. NIDHAM, Esq. Leicester.
1813.
Mar. 13. JAMES C. PRICHARD, M. D. F. L. S.
WILLIAM BULLOCK, Esq. London, F. L. S.
Dec. 4. Dr JAMES PROUD JOHNSON, Shrewsbury.
1814.
Jan. 8. Captain THOMAS BROWN.
EDMUND LOCKYER, Esq. Plymouth.
1815.
April 15. Dr GRIERSON, Cockpen.
1816.
Jan. 6. M. DACOSTA, London.
20. Captain COLBY, London.
Feb. 17. Dr HOLDER, Barbadoes.
Oct. 16. WILLIAM COUPER, M. D. Lecturer on Mineralogy, Glasgow.

1816.

Nov. 23. John Flemming, Esq. London.

Dec. 7. James Stewart Monteath, Esq. Closeburn.

21. Thomas Edington, Esq. Glasgow.

1817.

Jan. 18. Captain James Veitch, Royal Engineers.

May 3. James Agnew Farrel, Esq. Larne, Antrim.

June 7. James Strachan, Esq. Deputy Inspector of Hospitals, Banff.

Dec. 20. Sir John Meade, Tipperary, Ireland.

M. Kenney, Esq. Royal Artillery.

John Butter, Esq. Surgeon.

Dr Samuel Hibbert, Manchester.

FOREIGN.

1812.

Feb. 1. Don Timoteo Alvarez Verina.

1814.

Dec. 17. Professor Smith of Christiania, Norway.

John Spix, M. D. Munich.

Professor Schweigger, Berlin.

G. R. Von Sömmering, Privy Counsellor of State, Munich.

Professor Kurt Sprengel, Halle.

M. Lucas, Paris.

Franz. Von Paula Schrank, Munich.

Dr G. H. Schubert, Nüremberg.

Herr Von Schreiber, Director of the Royal and Imperial Cabinet of Natural History in Vienna.

Karl Von Raumer, Professor of Mineralogy, Breslaw.

Joseph Von Baader, Principal Captain of Mines, Munich.

1814.

Dec. 17. J. F. L. Hausmann, Professor of Mineralogy, Göttingen.

Hans Conrad Escher, Counsellor of State, Zurich.

1815.

Feb. 4. Baron Von Vitinghoff, Petersburgh.

Nov. 25. Jules Cesar Savigny, Paris.

Henri Ducrotay De Blainville, M. D. Paris.

F. A. Bonelli, Prof. Zoology, Turin.

1816.

Jan. 20. John W. Francis, M. D. Professor of Materia Medica, New York.

Feb. 3. Honourable De Witt Clinton, New York.

David Hossack, M. D. New York.

1817.

Jan. 18. Dr Lyal, Moscow.

May 3. Professor Zinken Somers, Altona.

M. De Brebisson of Falaise.

M. Gustavus Künze, Leipsic.

Frederick Parrot, M. D. Petersburgh.

Moritz Von Engelhardt, Petersburgh.

M. Lardy, Counsellor of Mines, Lusanne.

Professor Jurine, Geneva.

John Von Charpentier, Director of the Salt Works of Bex.

G. Brocchi, Inspector of Mines, Milan.

Luigi De Ruggiero, Professor of Mineralogy, Naples.

M. Gismondi, Professor of Mineralogy, Rome.

Baron Von Oppel, Dresden.

H. C. Ström, Counsellor of Mines, Drontheim.

Dr J. H. Kopp, Hanau.

F. S. Voigt, Counsellor of State and Professor, Jena.

His Excellency Count Alexis Razoumoffsky, Minister of Public Instruction, Moscow.

1817.

May 17. Dr Gotthelf Fischer, Professor of Natural History, Moscow.

Baron Hermelin, Stockholm.

George Wahlenberg, M. D. Upsal.

M. De Monteiro, Professor of Mineralogy, Coimbra.

Charles Blöde, Counsellor of Finances, Dresden.

Charles Böttiger, Counsellor of State, Dresden.

Chevalier Thynnefeldt, Gratz.

Professor Clevland, Boston.

H. Lichtenstein, M. D. Professor of Natural History, Berlin.

M. Von Eschwege, Director of Mines in Brazil.

G. R. Treviranus, M. D. Bremen.

J. G. Ebel, M. D. Zurich.

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A history of the proceedings of the Society, from its origin to the present time, is subjoined; and also an Index to both the 8vo volumes.

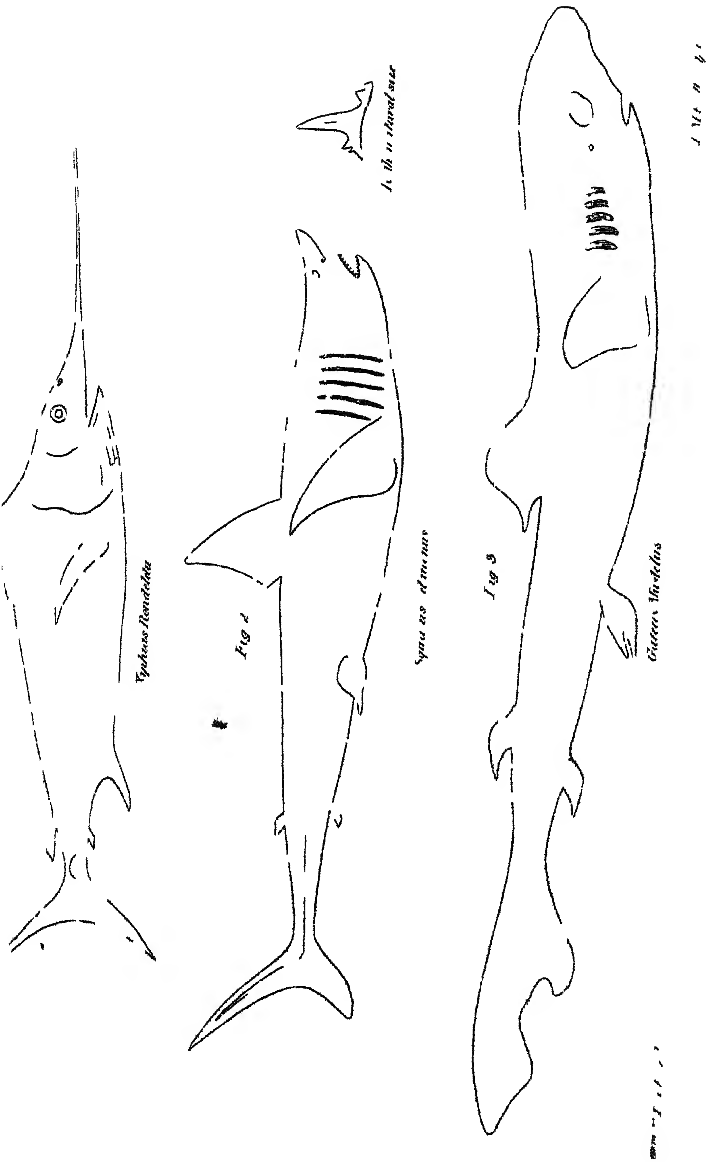
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Fig 3
Galeus Mustelus

E.Mitchell fc

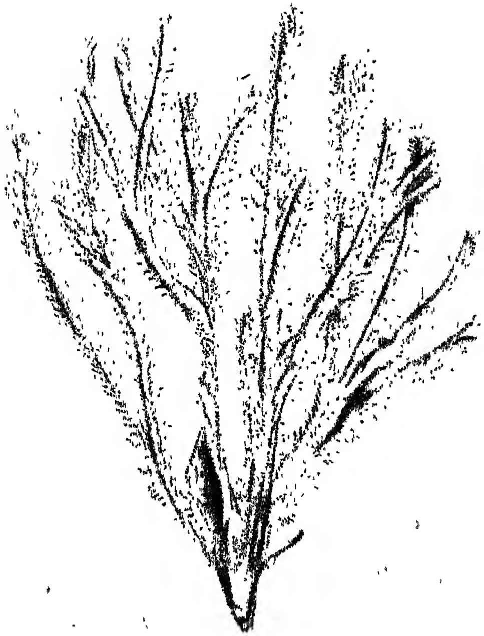

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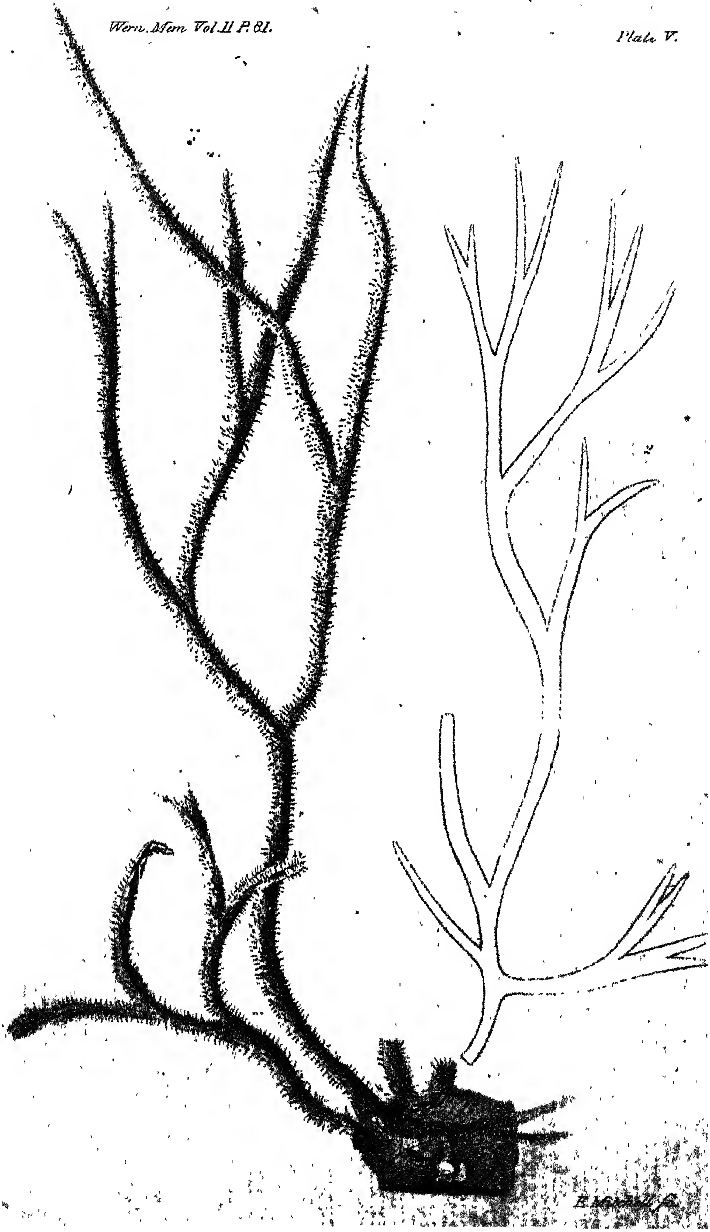
Plate V.



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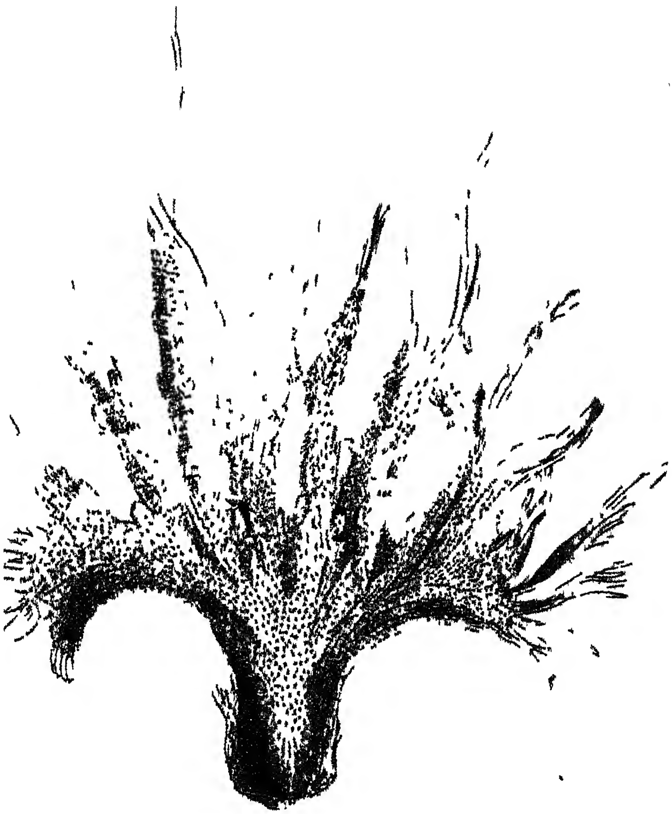

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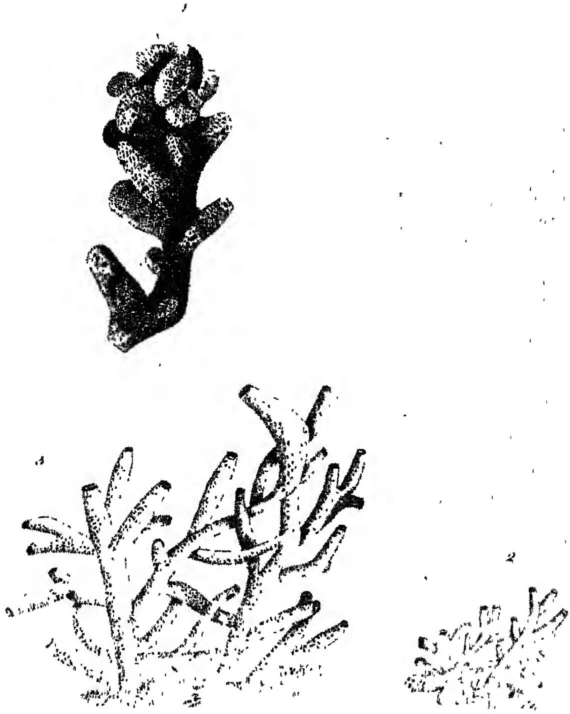

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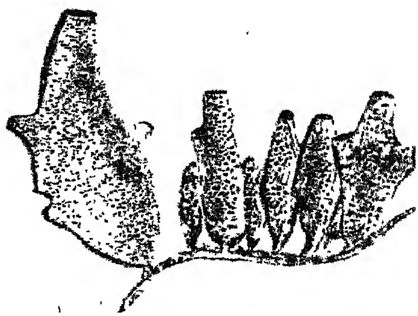

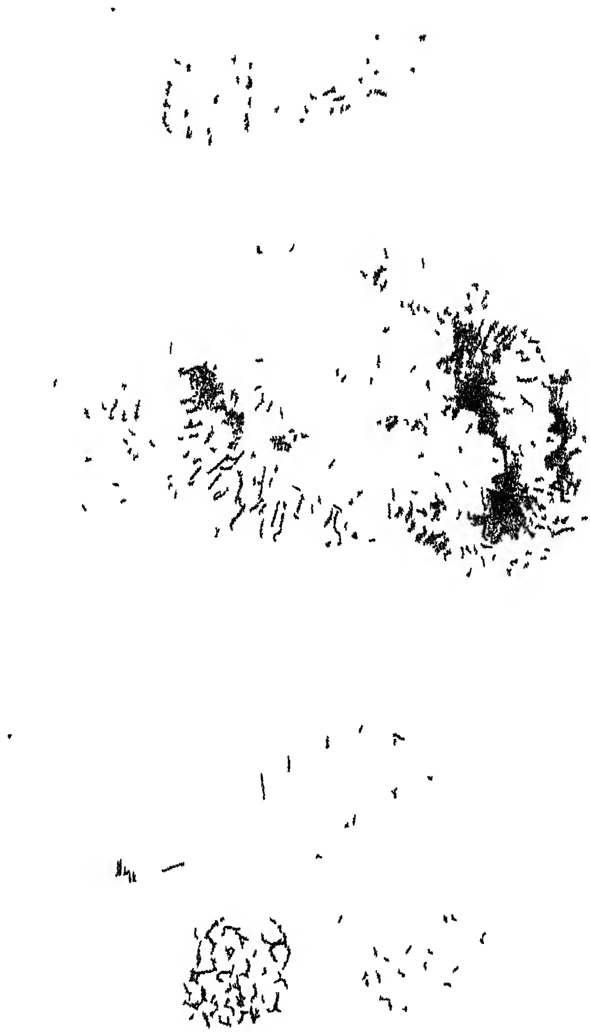

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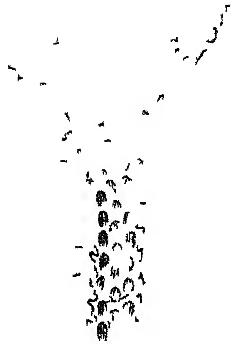

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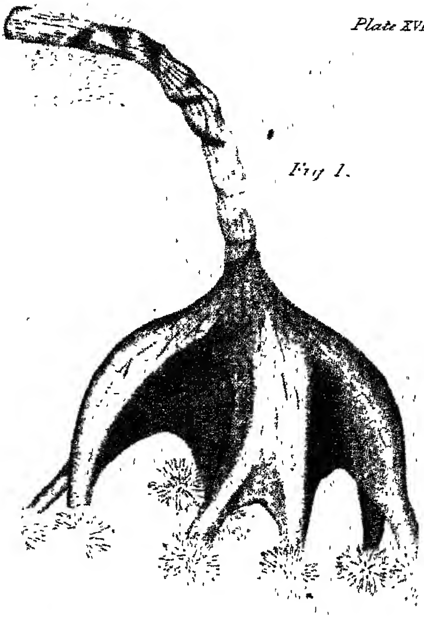

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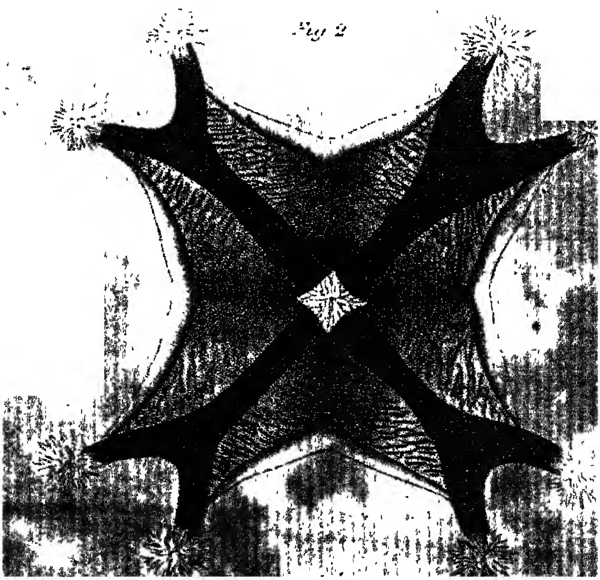

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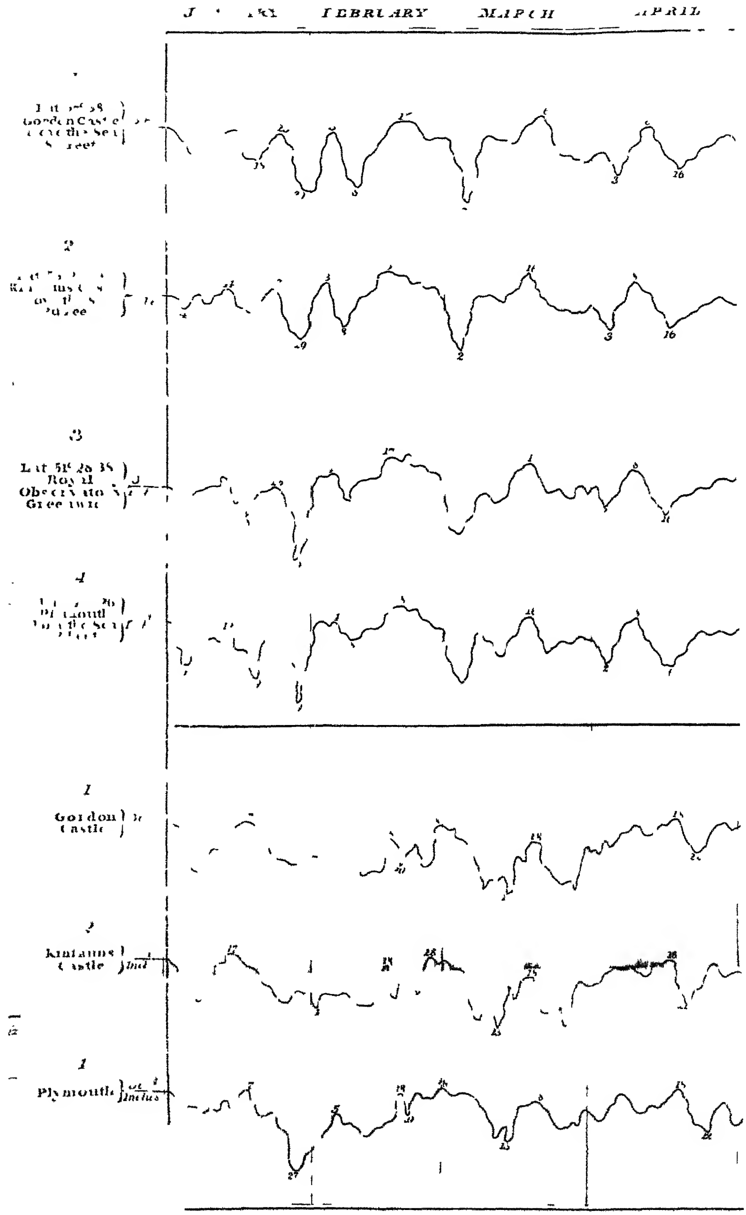

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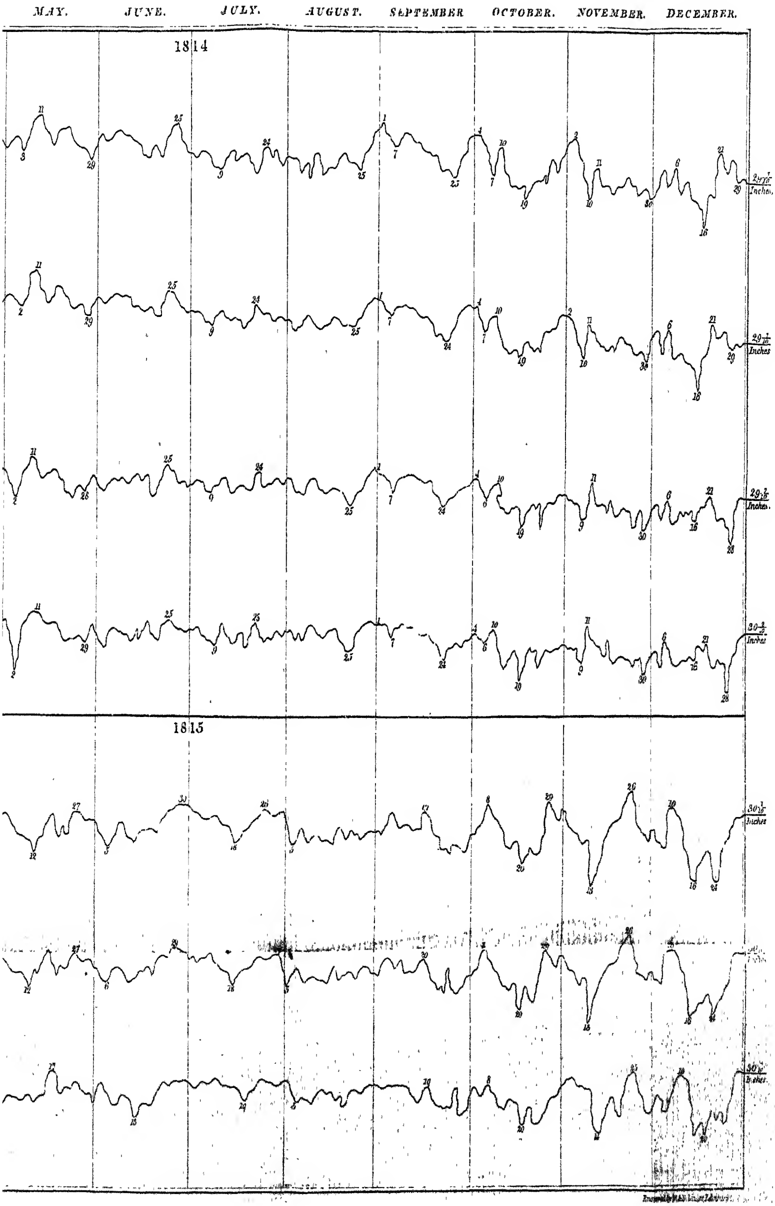

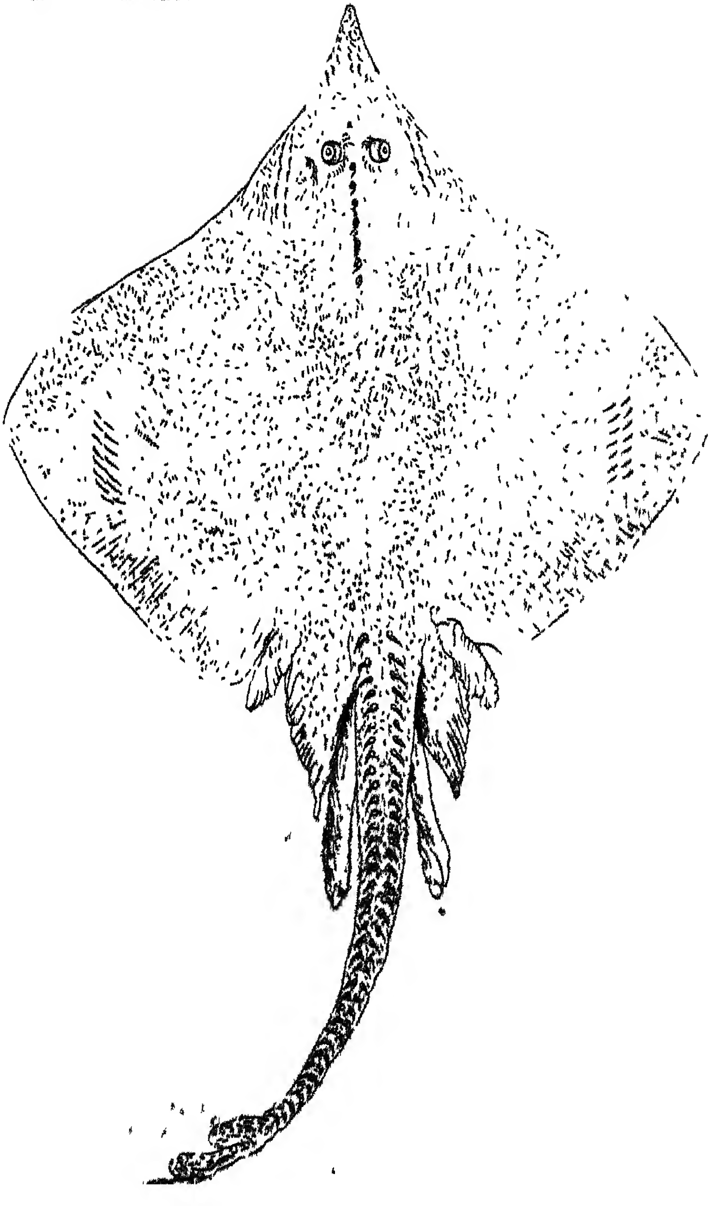

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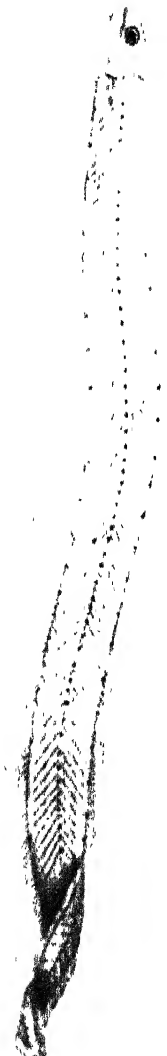

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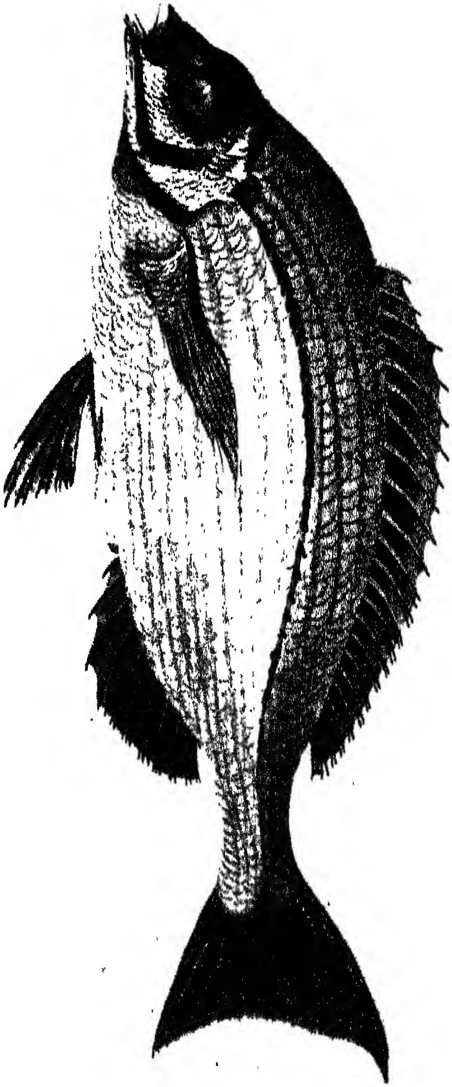

Thomas Brown del.

H. Mitchell sculp.